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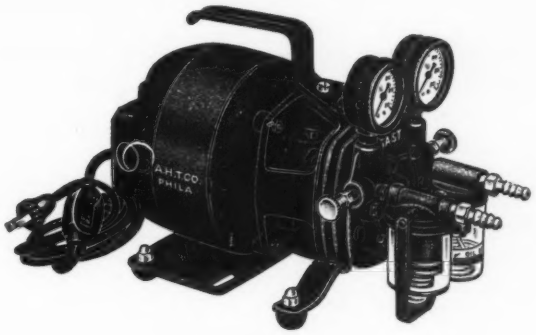

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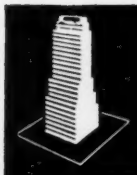

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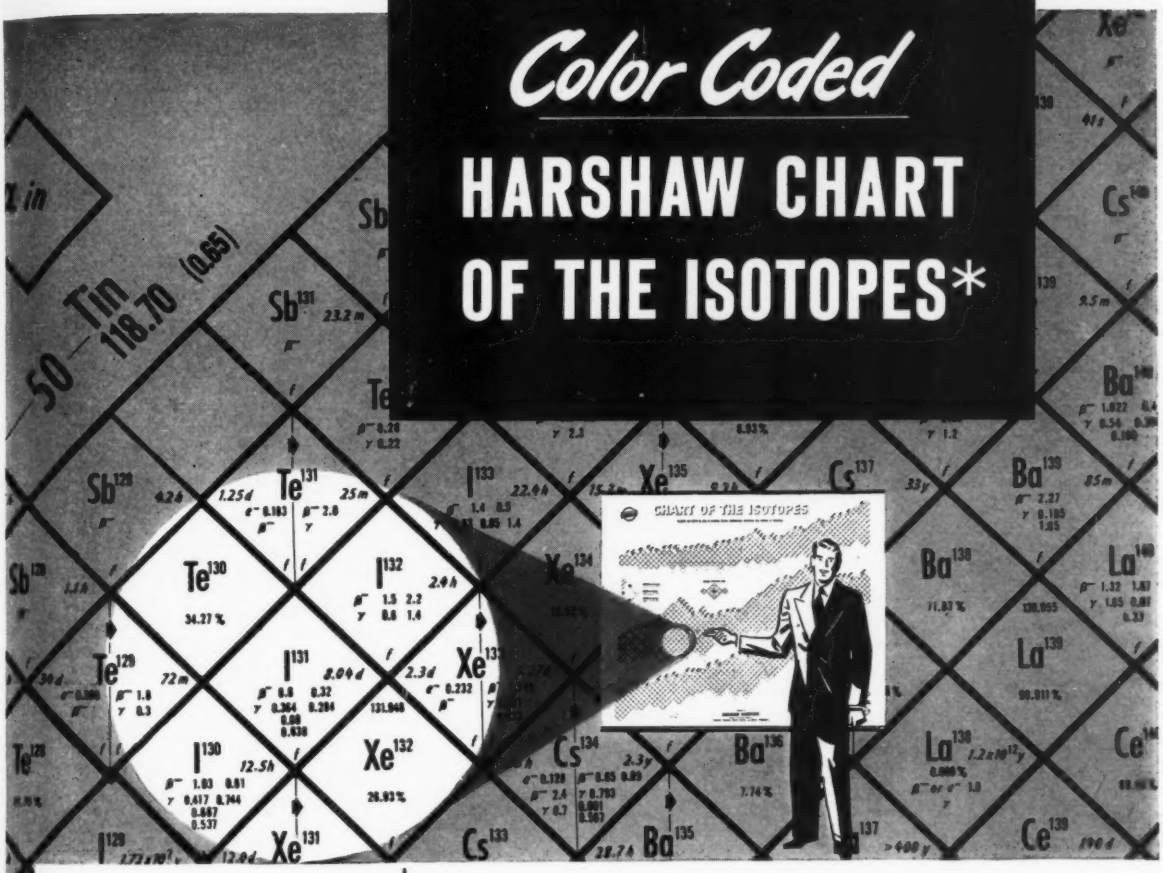

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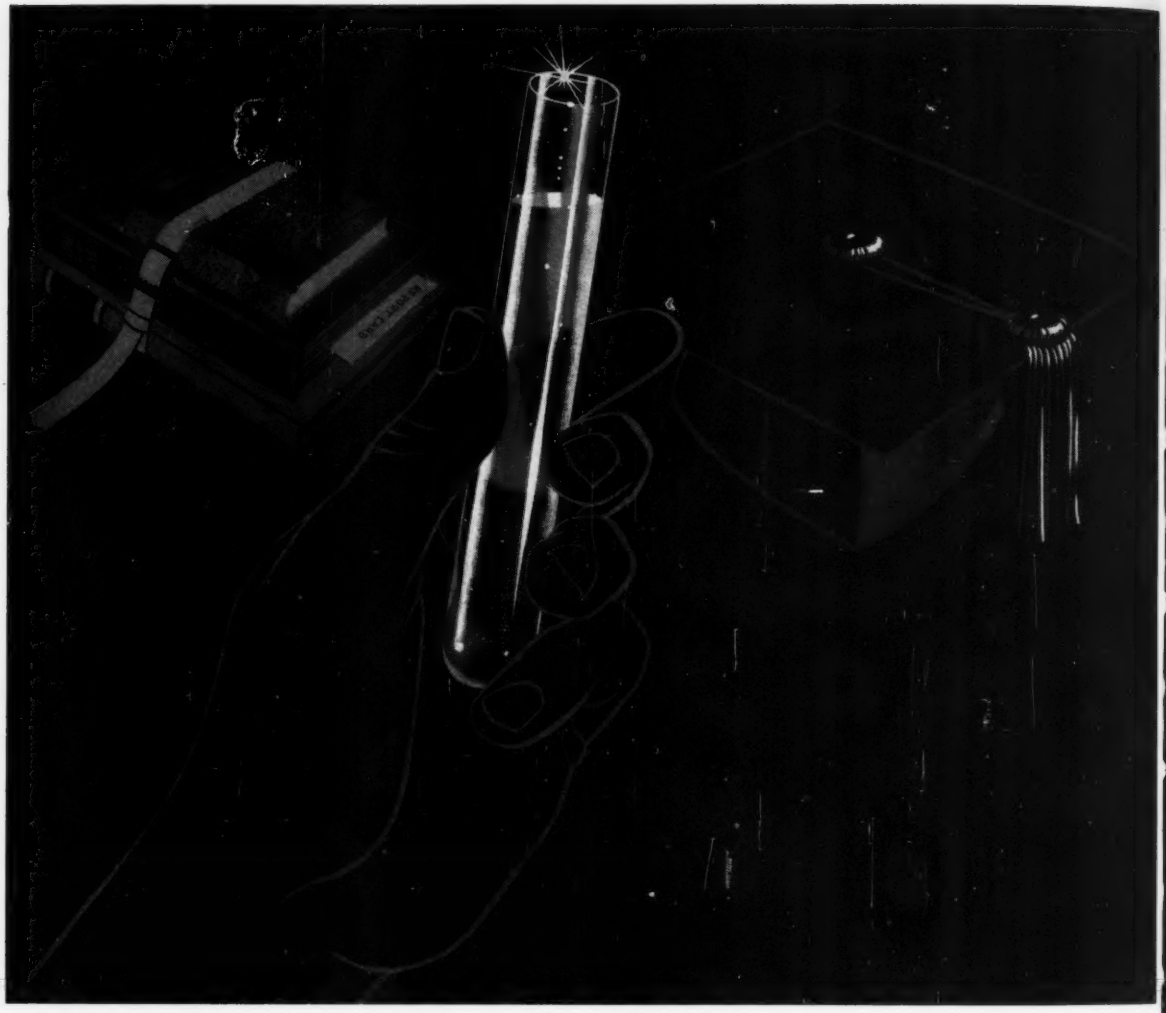

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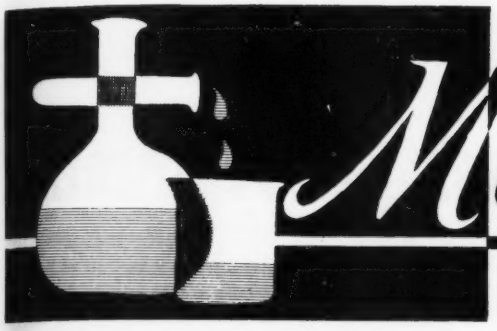

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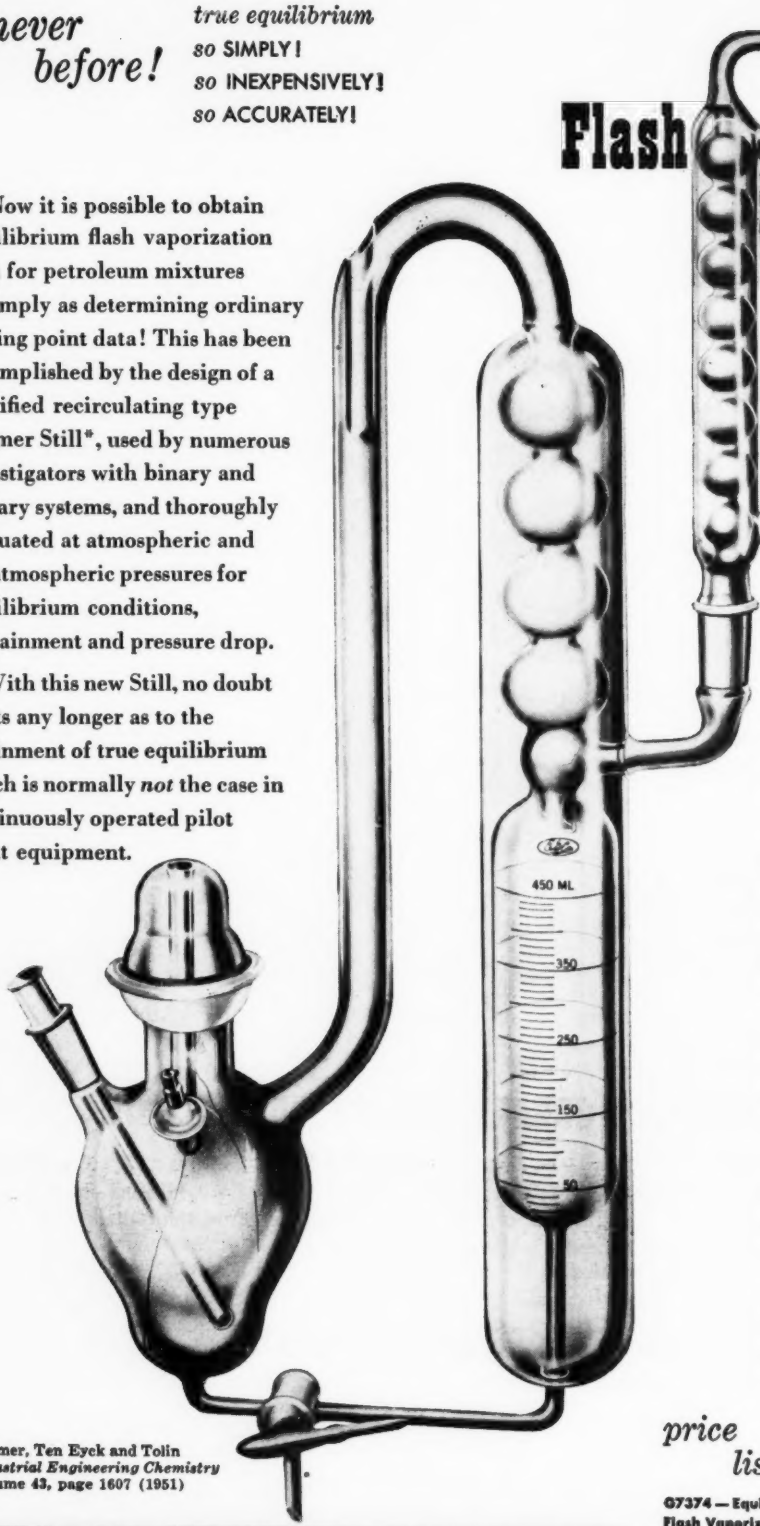

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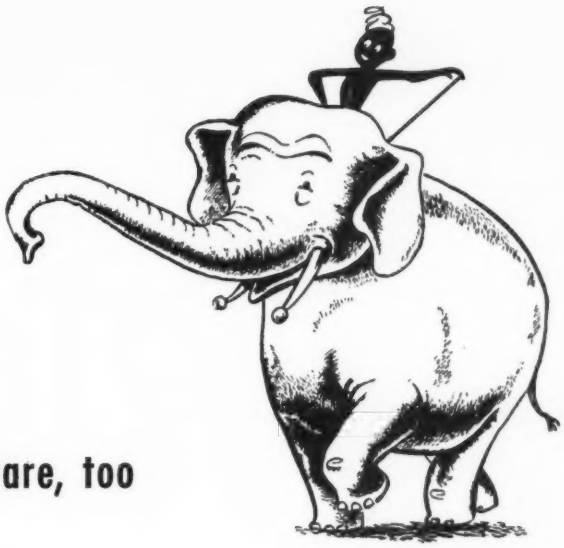

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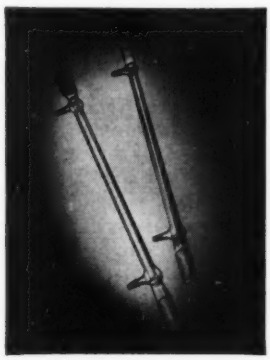

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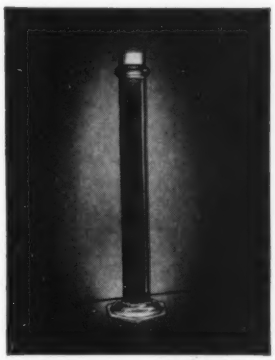

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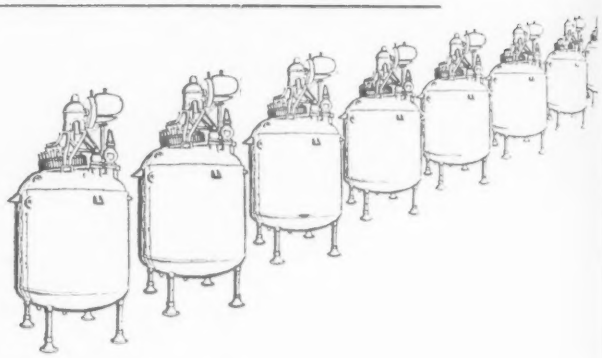

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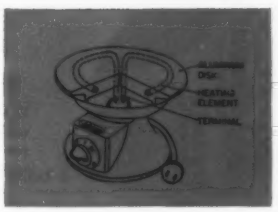

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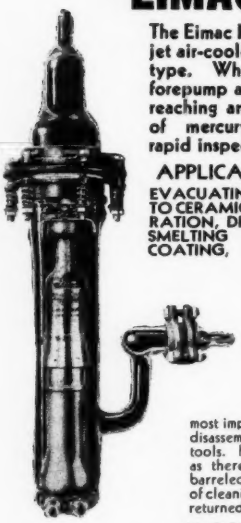

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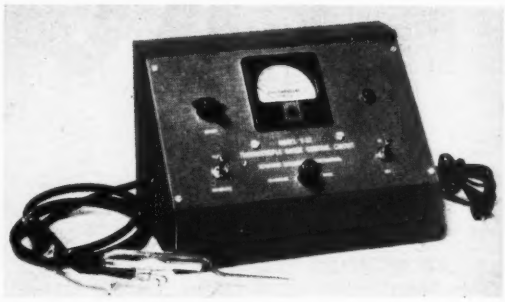

This equipment, which is designed to operate with the RCA type 1946 thermocouple gauge tube or equivalent, measures pressures in the range .001 to 1 mm Hg. The meter is calibrated to read air pressure directly. The unit is operated on 110 volt, 60 cycle ac, and consumes approximately 10 watts. It is mounted in a sloping front cabinet $6\frac{1}{2}'' \times 10'' \times 6\frac{1}{2}''$.

Operation is particularly simple. Calibration is checked by use of the same meter that reads the pressure. A ballast type circuit is employed in order to minimize error due to line voltage variation.

The thermocouple tube may be sealed directly to pyrex systems. An adapter (listed below) is available for use in connecting the tube to metal vacuum systems.

In addition to use as a pressure indicator, the gauge is useful for locating leaks in vacuum systems by noting sudden changes in reading when a material such as acetone is sprayed or painted on the suspected part of the system.

No. 84572, Izss thermocouple tube.....$69.50

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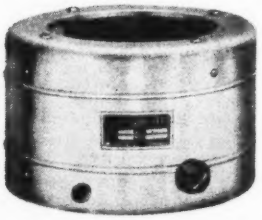

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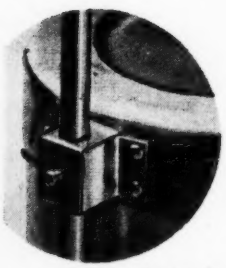

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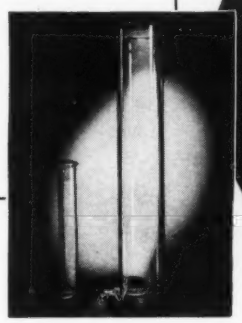

Compactly assembled in this apparatus are the necessary components for the sublimation process on a semimicro scale. It is particularly useful for the purification and identification of organic compounds which sublime in the range from room temperature to 300°C.

The apparatus incorporates suggestions of L. E. Miller of the University of Illinois, and consists of an electrically heated cylindrical aluminum block furnace mounted in line on a common frame with a water cooled condenser. Two cartridge type heaters are inserted into the metal block and supply heat at a rate determined by a variable transformer controlled by a front panel knob. The furnace is insulated on all sides and encased in an aluminum shell. It is provided with a thermometer well and is drilled axially to accommodate tubes up to 35 mm in diameter.

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Overall length, 11 inches; overall width, 4½ inches; overall height, 7¾ inches; maximum tube diameter accommodated, 35 mm; minimum tube length accommodated, 160 mm; maximum power consumption, 150 watts; net weight, 11 pounds.

Two types of sublimation tube, for semimicro and micro samples respectively, are offered for use with this apparatus. Each type consists of a standard test tube with a V-shaped indentation near the closed end which serves as a wall for retention of the sample.

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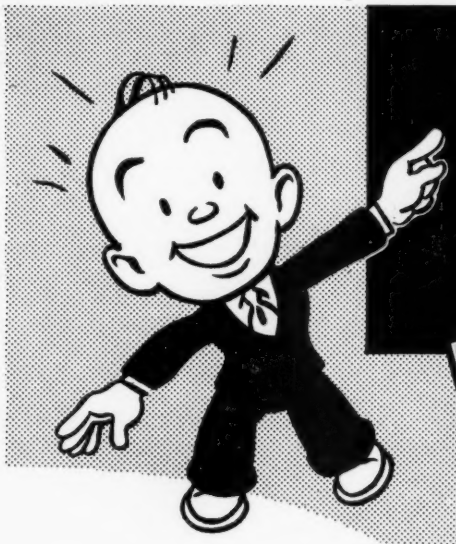

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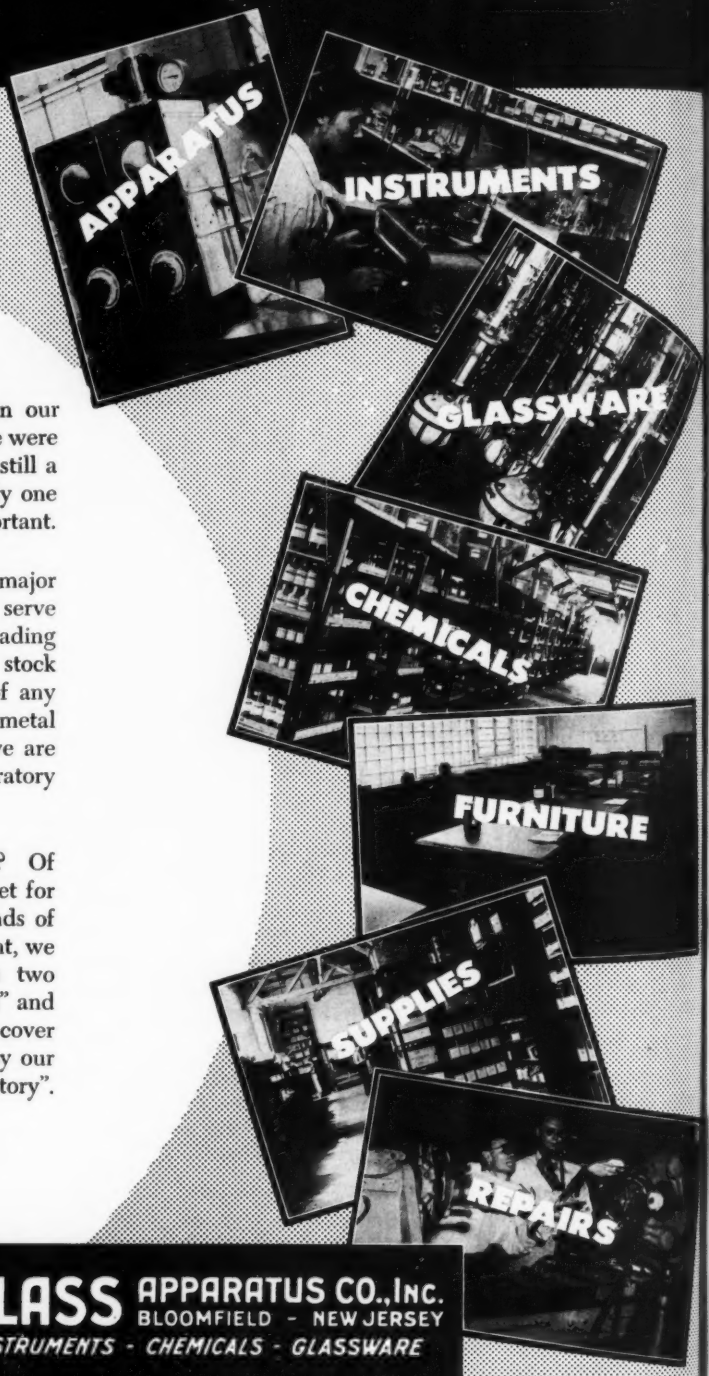

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(See page 414)

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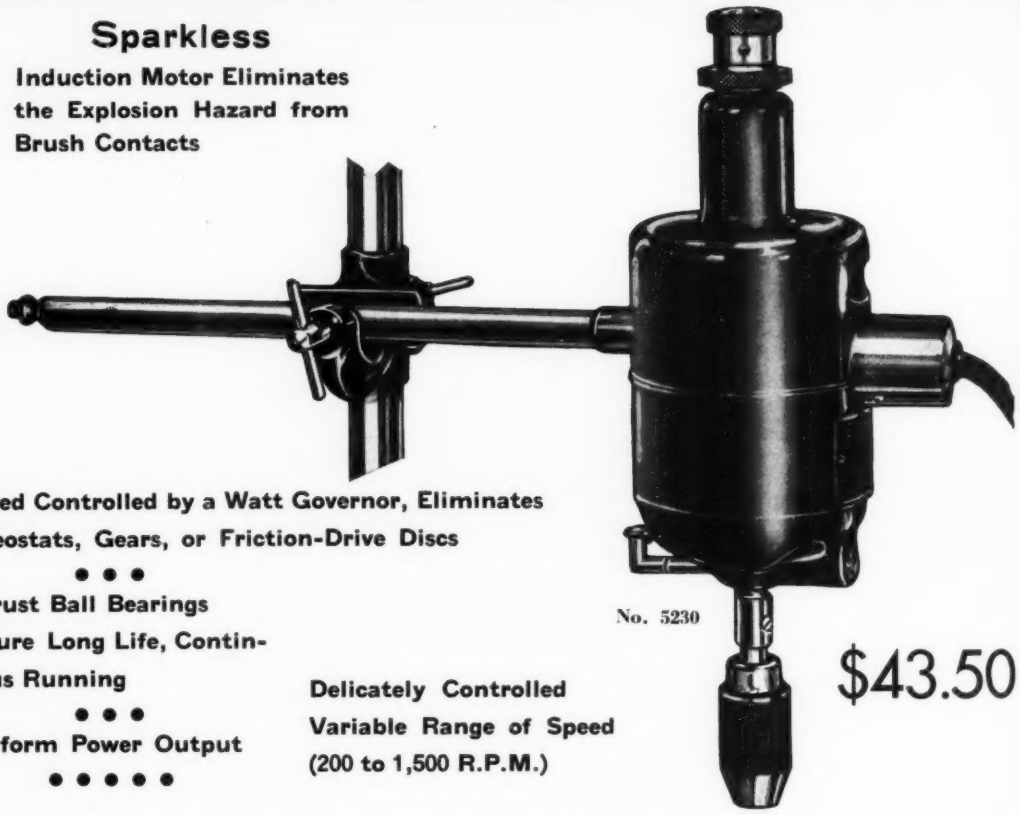

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This is not a friction drive outfit, the stirring rod being direct-connected to the motor shaft by means of a chuck which takes any size shank from 0 to 6.5 mm. and can be very tightly adjusted with the fingers. The speed of the motor is delicately controlled over a range from 200 to 1500 R.P.M. by means of a governor contained in the housing and activated by means of a very positive screw adjustment. The speed range is, therefore, from a minimum as low as ever desired up to the maximum speed of the motor. While the speed is manually controlled through the setting of the adjusting screw, the particular construction of the governor makes this speed control for a given setting automatic in that a decrease of speed (which might be due to an increase in viscosity of the liquid as the stirring progressed) brings the governor weights further in, thus reducing the friction between the control surfaces and automatically speeding up the motor. The reverse would be true in case the resistance to the stirring were suddenly or gradually lowered. In all other stirrers employing either the friction disc or the worm gear drive, there is no constancy of speed when variations of the line voltage or variations of the load occur.

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Editor's Outlook

THE editorial policy of THIS JOURNAL has long insisted upon a broad definition of chemical education, not restricted to the usual routines of the classroom but broad enough to include most or all of the process of dissemination of knowledge about chemistry.

A contribution to this general point of view is made by an article which I laid away some time ago for future reference and which I have just dug out and reread.[1] The author's general thesis is that the face-to-face meeting of teacher and student is only one setting for the teaching process, and since we inevitably and intentionally *teach* when we publish, there is not the sharp distinction between teaching and research which is assumed to exist. He says: "It is largely due to the need for teaching people who are not sophomores and cannot be coerced by college administrators to assemble at stated times and places that teaching of other kinds also seems to me to be important."

With this as a background he considers different kinds of publication: textbooks, video, reviews, monographs, abstracts.

He thinks it is poor practice for a successful and skillful classroom teacher to write a textbook, for to him the two activities require entirely different habits of mind. Tolerance and expediency lead to an entirely different scale of accuracy in class discussions and explanations from that which must be maintained when statements are permanently recorded in black and white. He thinks "that good teachers for classrooms and lecture-halls should probably not be allowed to write textbooks at all."

He makes a point as applicable in chemistry as in his own field of physics when he cautions against "a fever of enthusiasm for the so-called scientific method." Exponents of non-scientific fields should not be coerced into trying to follow a foreign method when there are others which are more proper and fruitful in their own fields. More important, a science like physics or chemistry has a life of its own, quite apart from its "method." This aspect can be lost sight of. "If we do not combat this creeping paralysis of our subject," he says, "we may some day find ourselves in the same oubliette with those Latin and Greek scholars of an earlier generation who lost the contents of their subjects, and their students as well, by concentrating on grammar and syntax at the expense of the classics they should have taught students to appreciate."

Excellent advice to anyone contemplating publication is given in a section on Condensation, which makes good music in an editor's ears:

> We used to rely entirely upon editors to prune papers submitted for publication, and they still do what they can; but the real place to use the shears is in the rooms where the original writing is done. It is a good rule to write a paper out, put it away for a week, and then revise it as if it had been written by a personal enemy, mercilessly excising the trite, the obvious, and the inconsequential, and straightening up every deviation from the straight and narrow way to truth. It is also an author's responsibility to write his own abstract. If the abstract is all that is really needed, may not the paper be dispensed with? If nothing at all is left, as may well happen, everybody will be happier.
>
> In the process of condensation here advocated, it will often occur that a tubful of soup containing more than one oyster can eventually be served in two or three cups each containing a prize, and the chance of missing good things in too long a paper with too short a title will be much reduced. Incidentally, those whose scientific production is measured by counting titles in a president's report might even gain a little credit for making two blades of grass grow where one blade of hay might have dried up unnoticed.

[1] MCKEEHAN, L. W., "Teaching by publication," *Am. J. Physics*, **19**, 9 (1951).

HLASIWETZ AND BARTH—PIONEERS IN THE STRUCTURAL ASPECTS OF PLANT PRODUCTS

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Newcomb College, Tulane University,
New Orleans, Louisiana

THE contributions of Hlasiwetz and Barth to our knowledge of the chemistry of plant substances were in a sense the result of the activities of Justus Liebig. Although investigation into the nature of plant extracts had been carried on with great interest since the beginning of the nineteenth century, especially by the French chemists, it was Liebig's interest in agricultural chemistry and his discoveries in the laboratory he had established at Giessen in 1824 which stimulated admiration in Austria. Students from Austria went to Giessen for study, and among these were Redtenbacher and Rochleder who in turn trained Hlasiwetz. It is interesting to note that although Hlasiwetz did not study at Giessen, he nevertheless continued certain phases of chemistry that were systematically investigated by Liebig—glycosides and proteins. Barth studied under Liebig for a year at Munich. Moreover both Hlasiwetz and his student Barth followed the example set by Liebig, that of keeping up with advances in chemistry in all the great laboratories of Europe, and as early as 1861 both accepted the new atomic weights advocated by resolution at the Congress of Karlsruhe in 1860. The laboratory methods of these men pioneered in the exact analysis of plant extracts and of the compounds obtained from them. These investigations procured for their authors the name of clear, original thinkers and exact workers.

HLASIWETZ

Heinrich (Hermann Christian) Hlasiwetz, eminent teacher and one of the most important Austrian chemists of his time, was born on April 7, 1825, at Reichenberg in Northern Bohemia, the son of the town apothecary. In 1835 he went to the gymnasium at Prague and while there, because of his outstanding talent, was also a student at the music school of Procksh. Four years later he returned home and worked with his father as an apprentice. During this time he acquired practical chemical, botanical, and mineralogical knowledge. In 1842 he entered the University at Jena, attending the Pharmaceutical Institute with the idea of taking charge of his father's pharmacy. Among his teachers were Döbereiner, Wackenroder, and Schleiden. The latter, an enthusiastic teacher, almost persuaded Hlasiwetz to follow a career in botany, but his preference for organic chemistry conquered. In 1843 he returned to Reichenberg in order to persuade his father to agree to his decision to pursue a scientific career. This the elder Hlasiwetz finally did with the stipulation that his son should first finish his study of pharmacy. We find him, therefore, from 1843 to 1846 as practicing apothecary in Brünn, Vienna, and Reichenberg. This done he devoted himself entirely to his professional studies under Redenbacher in Prague, where in 1848 he was awarded a diploma as master pharmacist. During these years he also carried on his scientific studies and on April 16, 1849, he was graduated as Doctor of Chemistry. Throughout his whole career he maintained his interest in music.

As a young doctor, Hlasiwetz' closest friend was Friedrich Rochleder, to whom he was assistant and who was Redtenbacher's successor at Prague. Rochleder's chief interest was the study of the nature of plant substances, but he was also interested in theoretical speculation, publishing in 1853–54 articles on the radical theory.[1] Hlasiwetz' first research was a study of asafetida oil, in which he set forth the formula of this well-known substance, described its platinum and mercury compounds and investigated the action of chlorine, of hydrochloric acid, and of potash on it.[2] During the next few years he worked with Rochleder on plant products, their characteristics, stability to oxidation, and reaction to acids and alkalies,[3] as well as doing some independent work on acetone.[4]

INNSBRUCK

In 1851 he was called to Innsbruck as Professor Extraordinary for the newly established Chair of Chemistry. Here he first exhibited his talent for organization, for no laboratory, no library, and no students were there when he arrived. In a remarkably short time he built up an institution highly esteemed locally and in foreign countries; the number of his students increased so that he required assistants, and a government grant was made for the laboratory. Two years later he was appointed Ordinarius. An excellent teacher, he instructed his students at their work tables, spurred them to activity, and discussed their problems with them so that they could work with understanding and independence. He was strict and conscientious in his requirements, demanding full devotion to the matter in hand; thus he gathered a group like

[1] *V. Acad.*, XI (1853); XII (1854). *Ann.*, **87**, 196 (1853).
[2] *Ann.*, **71**, 23 (1849).
[3] *Ibid.*, **76**, 338 (1850); **82**, 197 (1851).
[4] *Ibid.*, **76**, 294 (1850).

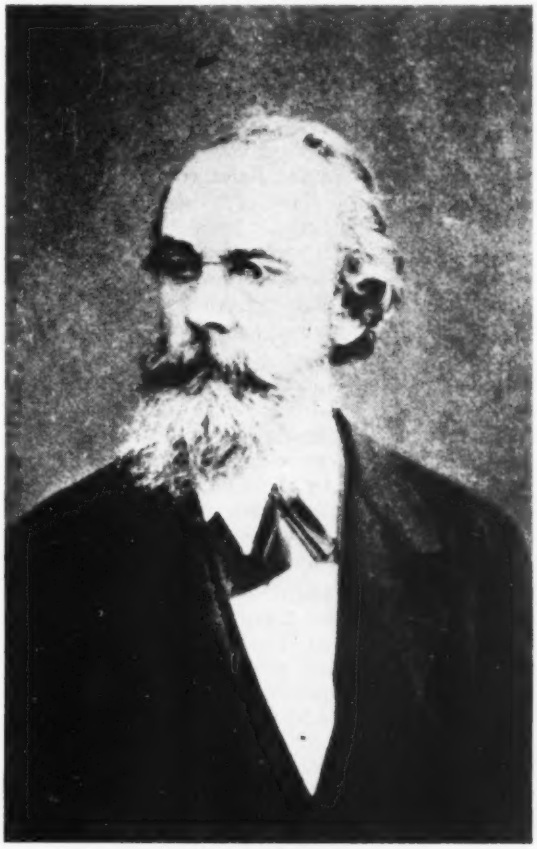
him in zeal, earnestness, and knowledge. Among these were Buckeisen, von Gilm, Nachbar, Barth, Pfaundler, Mössmer, Graf Grabowski, Rembold, and Malin.

Hlasiwetz remained at Innsbruck 16 years, during which time he traveled widely on the continent and to England, Scotland, Sweden, and Norway, where he studied the various establishments, collections, institutions of learning, and industrial plants. These years were fruitful in publications and discoveries of new organic compounds obtained from plant leaves, bark, roots, or resins by potash fusion. By this means he decomposed phloretin (dihydronaringenin, *p*-$HOC_6H_4(CH_2)_2COC_6H_2(OH)_3$ 1,2,4,6) obtained from the glucoside phloridzin, and found two new substances, phloretinic acid[5] (*p*-hydroxycoumaric, *p*-$HOC_6H_4(CH_2)_2COOH$) and phloroglucinol[6] (1,3,5-trihydroxybenzene). This method was also applied to the glycosides ononin,[7] quinovin,[8] quercitrin,[9] and carminic acid.[10] He discovered that quercitrin was similar to rutin, found earlier in capers, and that quercetin and a sugar were obtained from it upon hydrolysis.[11] With Pfaundler he isolated the sugar, found its formula to be $C_6H_{10}O_5 + H_2O$ and called it isodulcit.[12] It is a methyl pentose now known as rhamnose, and quercetin is known to be 3,5,7,3′,4′-pentahydroxy flavone. He showed that quercetin was decomposed into protocatechuic acid (3,4-dihydroxybenzoic) and phloroglucinol when heated with potassium hydroxide, but that under certain circumstances intermediates could be isolated. Two of these were quercetin acid, related to ellagic acid (later studied by Barth) and *p*-carthamin ($(OH)_4$—C_6HCOCH=CHC_6H_4OH). He mentioned further that the irregular values found by analysis of different preparations of quercitrin justified the hypothesis that there were various quercitrins containing more or less sugar units or different sugar-like substances attached by ether linkages. This deduction proved correct: quercitrin is quercetin-3-rhamnoside; rutin is quercetin-3-rhamno-glucoside; and quercimeritrin is quercetin-7-glucoside. Later investigation of these compounds is due to Kosteneki[13] and Robinson[14] who worked out a large number of useful syntheses by which the flavones can be obtained relatively easily, and to A. G. Perkin.[15] The structure of quercitrin was worked out in 1936 during a study of diuretic drugs.[16] Since 1936 most of the work on these compounds has been done by members of the Indian Chemical Society and the Indian Academy of Science.

[5] *Ann.*, **96**, 118 (1855); **102**, 145 (1857).
[6] *Ibid.*, **112**, 180 (1859); **119**, 199 (1861).
[7] *J. Prakt. Chem.*, **65**, 419 (1856).
[8] *Ann.*, **111**, 182 (1859).
[9] *Ibid.*, **96**, 123 (1855); **122**, 96 (1859).
[10] *Ibid.*, **141**, 329 (1867).
[11] *J. Prakt. Chem.*, **67**, 97 (1856); *Ann.*, **96**, 123 (1855).
[12] *Ann.*, **127**, 362 (1863).
[13] *Ber.*, **37**, 784, 1402, 2819 (1904).
[14] *J. Chem. Soc.*, **125**, 2192 (1924).
[15] *Ibid.*, **85**, 1459 (1904); **105**, 2350 (1914).
[16] *J. Pharm. Soc., Japan*, **56**, 68 (1936); *Chem.-Zentr.*, **2**, 2919 (1936).

RESINS

Almost at the same time as his work on glycosides, Hlasiwetz began the investigation of resins. In the distillation products of guaiacum resin he detected guaiacol (*o*-methoxyphenol) and its homologue creosole[17] (3,1,4-$CH_3OC_6H_3(CH_3)OH$). Guaiacol had been



Heinrich Hlasiwetz

obtained in 1826 by the dry distillation of guaiacum by Unverdorben. With the help of Barth, his assistant, he studied a series of gums and resins by means of the following procedure: The crude substance was purified by treatment with alcohol or alkali to separate it from mechanical impurities. It was then melted with about three times its amount of potash until the usual strong froth slackened; the mixture was acidified, filtered, and extracted with ether. The ethereal solution was dried by evaporation and the various components separated by crystallization, etc. The resins explored were: guaiacum,[18] gum benzoin, drachenblut, aloes,[19] asafetida, gamboge,[20] acaroid resin,

[17] *Ann.*, **106**, 339 (1858).
[18] *Ibid.*, **130**, 346 (1864).
[19] *Ibid.*, **134**, 265 (1865).
[20] *Ibid.*, **138**, 61 (1866).

sagepenum, opopanax,[21] and galbanum.[22] The various decomposition products obtained were acetic acid, benzoic acid, *p*-hydroxybenzoic acid, pyrotartaric acid (methyl succinic), protocatechuic acid, catechol, phloroglucinol, orcinol (5-methyl resorcinol), resorcinol, and homophthalic acid. They succeeded in isolating for the first time *p*-coumaric acid[23] (*p*-hydroxy-cinnamic, p-$HOC_6H_4CH{=}CHCOOH$) from aloes and ferulic acid (3,4,1-methoxy-hydroxy-cinnamic) from asafetida, both of which are intermediates, as the former may be broken down into acetic acid and *p*-hydroxybenzoic and the latter into acetic acid and protocatechuic acid.

Homophthalic acid (*o*-carboxy-phenyl acetic) was obtained by Hlasiwetz and Barth from gamboge, and named isuvitic acid because of its similarity to uvitic acid (5-methyl-isophthalic). It received its present name from J. Schreder[24] who showed that it is identical with the phenyl-aceto-carboxy acid obtained by Wislicenus from potassium cyanide and phthalide.[25]

Resorcinol (*m*-di-hydroxybenzene) obtained from galbanum was the subject of much research. It was recognized as an isomer of catechol (discovered in 1839 by Reinach) and hydroquinone (discovered 1844 by Wöhler) and a homologue of orcinol, and its use as a dye intermediate and in medicinals soon followed. It was later obtained by the dry distillation of umbelliferone[26] (p-hydroxy-coumarin) which comes from the resins of a number of umbelliferae.

Hlasiwetz and Barth carried out experiments on synthetic resin building.[27] A resin was produced by the reaction of phosphoric acid on benzaldehyde that was very like natural gum benzoin. At another time they obtained resinous substances with properties like that of natural turpentine resin. Like these it was with difficulty attacked by caustic alkali.

TANNINS

Researches on glycosides, resins, and related compounds led Hlasiwetz to the so-called tannic acids (tannins). The latter substances have since been divided into two groups by Freudenberg:[28] (1) the hydrolyzable type (such as the tea tannnis) which are glycosides or depside esters of sugars and (2) condensed tannins in which the nuclei are held together by carbon linkages (such as the catechins and kinotannic acid). Constitutionally the latter have been proved by Russell to resemble anthocyanins[29] and flavone derivatives, with which Hlasiwetz was familiar. He began with a study of caffetannic acid, obtained a new acid, caffeic acid (3,4-dihydroxycinnamic), and a sugar, upon boiling it with moderately strong potassium hydroxide, and showed it to be a glycoside.[30] With Malin he studied the constitution of tea[31] and found in it tannic, gallic (3,4,5-trihydroxybenzoic), and oxalic acids. Upon boiling with dilute sulfuric acid, the tannic acid, a glucoside, was hydrolyzed into quercetin and glucose. He regarded the tannic acids as intermediates in the formation of complex glycosides. Tannic acids are are now known to be polymeric glycoside derivatives of gallic acid containing a number of acidic groups, some bound as antimonyl groups. These investigations led him to classify glycosides according to their decomposition products, as follows:

(1) True glucosides which yield glucose and an aromatic compound.
(2) Phloroglucides which yield phloroglucinol and a sugar (ploretin, quercetin, catechin).
(3) Phloroglucosides which yield a phloroglucide and a sugar (quercitrin yields quercetin and β-rhamnose).
(4) Gummides which yield a sugar and a gum (carminic acid).
(5) Mannides which yield mannitol (caffetannic acid and quinovin).
(6) Nitrogen-bearing glucosides.

At that time the term glucoside was used to designate compounds composed of a sugar and a hydroxy compound (or other residue containing an active hydrogen). It is still loosely used in this sense, although glycosides are now classified as to the kind of sugar they contain and the term glucoside should be reserved for glucose-bearing compounds. The glycosides are analogous to the acetals and like them are stable toward alkaline hydrolysis but are hydrolyzed easily in acid media. Potash fusion results in a more complete breakdown than does simple hydrolysis.

IN VIENNA

The years 1860–65, in which Hlasiwetz was most active in the laboratory, also were the years of his greatest musical activity. He composed an opera, various songs, and sonatas, some of which enjoyed the approval of skilled professionals and critics. He also played the piano with considerable virtuosity. His creative power must have been at its height in this period and, as already pointed out he was thoroughly alive to the changes in chemistry which followed the Conference of Karlsruhe which he undersigned and attended.[32] Austria began to pay him honor in 1861 when he was named a corresponding member by the Vienna Academy of Science, and two years later a full member. In 1864 he was honored by the University by being chosen Rector, and in 1865 His Majesty bestowed on him, in recognition of his work in science and teaching, the order of Franz Josef. Five years later he was elected to the Vienna Society of Chemistry and Physics and the Imperial Bavarian Academy of Science.

A new chair of chemical technology was established at the Vienna Polytechnic, and on June 5, 1867,

[21] *Ann.*, **139**, 77 (1866).
[22] *Ibid.*, **130**, 354 (1864).
[23] *Ibid.*, **136**, 31 (1865).
[24] *Monatsh. Chem.*, **6**, 168 (1885).
[25] *Ber.*, **18**, 172 (1885).
[26] *Ann.*, **139**, 99 (1866); *Ber.*, **4**, 550 (1871).
[27] *Ibid.*, **139**, 83 (1866).
[28] FREUDENBERG, K., "Chemie der natürlichen Gerbstoffe," 2nd ed., Berlin, 1932.
[29] *J. Chem. Soc.*, **139**, 218 (1934); **142**, 421 (1937).
[30] *Ann.*, **142**, 219 (1867).
[31] *J. Prakt. Chem.*, **101**, 109 (1867).
[32] J. CHEM. EDUC., **28**, 421 (1951).

Hlasiwetz was named professor of this department. During the holidays, in order to prepare for his new teaching activity, he made trips to various factories, smelting works and mines. At the end of August he went to the salt mines near Hall in the Tyrol. Through an accident he lost his footing by the entrance to a deep shaft and suffered a broken leg in the fall. Not entirely recovered, he left on the 19th of October for his new post. One year passed before his laboratory was organized and research could begin again. He had hardly begun work on the behavior of turpentine oil on heating[33] when Schrötter was called to be Master of the Mint and Hlasiwetz was named his successor (January 25, 1869) as Professor of Chemistry, at the same institution. He remained in this position until his death although other opportunities were offered him, such as one in 1870 from the University of Vienna and also a request to become Liebig's successor at Munich. Here he again succeeded in training a succession of skillful workers such as Weselsky, his later successor, Sommaruga, Habermann, Kachler, Weidel, J. Schreder, and Benedict.

In 1871 he began work on potassium hexacarbonyl. Through a fearful explosion he was badly burned on his face and hands, and many weeks elapsed before he could take up his work again. In this same year he was chosen to the Board of Directors of the Vienna Musical Society, and Rector of the Polytechnic. In the latter capacity he took a prominent part in the preparation of new regulations for this institution. He was active on behalf of the German Chemical Society on the statute revision commission, having already (1870) functioned as a member of the foreign committee. He was named Councillor (Hofrath) in the Government Teaching Ministry and was entrusted with conducting the Department of Technical Universities, commercial schools, nautical and other technical institutions.

In March, 1875, he became acquainted with a highly educated young woman, Marie Freiin von Ankershofen, who shared his love of music. They were married in July and he took her on a wedding trip to Italy and Switzerland. On the evening of the seventh of October he went with his wife to visit a group of close friends. The next morning as he was leaving his house to go to the laboratory a cardiac paralysis brought his life to a sudden end.

PROTEINS

The most important work of this later epoch was unquestionably that with Habermann on splitting proteins.[34] They chose as reagents bromine and water, followed by silver oxide. They found a parallel between this degradation and the decomposition of the carbohydrates. They found further that all proteins gave the same decomposition products qualitatively but that the relative amounts varied. In a second work, they attempted to find the primary decomposition products of proteins and chose hydrochloric acid in the presence of stannous chloride on casein.[35] They obtained aspartic acid, glutamic acid, leucine, tyrosine, and ammonia, but no carbohydrates as end products. They concluded that carbohydrates are not concerned in the constitution of proteins and stated, "The differences in the properties of the various proteins lies in the different ratios of the primary groups constituting them."[36]

Hlasiwetz wrote the following articles: "On photography," "On the chemistry of earthenware," "On mortar and cement," and "On the composition of animal fluids." He also wrote a book, "Instruction in Qualitative Chemical Analysis" with Weselsky, proof of his command of many subjects.

BARTH

Ludwig Barth von Barthenau was born on the 17th of January, 1839, in Roveredo in the Tyrol (near the Italian border of Austria), the son of the chief civil officer of the district, Franz von Barth. Here he lived until his father was transferred in swift succession to Schwaz, Imst, and Bregenz. In 1850 his father was sent to Innsbruck and he went to the gymnasium there after a year with a private tutor. He was the youngest as well as the largest boy in his class. (Indeed, as professor at Innsbruck one of his first regulations was to have straightened the heavy iron lever which he had bent as a boy.) His progress was excellent, and in July, 1856, he passed the entrance examinations for the university and without hesitation entered on the study of chemistry. His incomparable teacher, Hlasiwetz, he had known earlier. In the laboratory his activity was characterized by skill, zeal, and industry, and in the year 1858 he published a note on camphol acid.[37] He was a gymnast, swimmer, rider, dancer, and fencer, but his preference lay in hunting and long walks. He was great in body and soul and kindliness was one of his outstanding characteristics. In the year 1859 he was among the first to apply for service in a volunteer academic rifle company. In the following semester we find him in Munich attracted there by Liebig and Pettenkofer. At the same time he enlisted in the Corps Franconia. In the summer semester of 1860 he returned to Innsbruck and when only 21 years of age he was awarded the Ph.D. degree. In another two years he was Privatdocent. At this time he worked on poisonous compounds, the picrotoxins, work which he resumed 20 years later with Michael Kretschy.[38] In 1864 he was appointed assistant to Hlasiwetz.

In the summer of 1866 we find him again on the southern border of the Tyrol, this time as Lieutenant of a voluntary defense company. Soon after the campaign, Barth was named Ordinarius for general chemistry at the University of Innsbruck as successor to Hlasiwetz (August 4, 1867). During the Easter holi-

[33] *J. Prakt. Chem.*, **103**, 316 (1868).
[34] *Ann.*, **159**, 304 (1871).
[35] *Ann.*, **169**, 150 (1873).
[36] *Ber.*, **9**, 1982 (1876).
[37] *Ann.*, **107**, 249 (1858).
[38] *Monatsh. Chem.*, **2**, 796 (1881); **5**, 65 (1884).

Ludwig Barth von Barthenau

days of 1869 he married Maria Kammerlander. They were a very devoted couple but had no children. During the next eight years Barth did extensive research on hydroxy aromatic acids. In the "History of tyrosine"[39] he showed the falsity of the prevalent view that tyrosine was a derivative of salicylic acid, since he had obtained *p*-hydroxybenzoic acid as a result of potash fusion. He studied the constitution of tyrosine and proposed its correct formula.[40] He studied protocatechuic acid,[41] in detail, noting its basicity, its isomers, its similarity to benzoic, *p*-hydroxy benzoic, and gallic acids, and its synthesis from *m*-hydroxy benzoic acid, which he had previously investigated.[42] Protocatechuic acid had been obtained by Hlasiwetz from the potash fusion of guaiaretic acid from guaiacum[43] resin (the method now used). Barth noted that from bromoprotocatechuic acid a substance resembling gallic acid was obtained. Gallic acid, used in inks and dyestuffs, is now made by fusion of the two isomeric dihydroxybenzoic acids with alkali. He converted *o*- and *p*-toluenesulfonic acids and *p*-cresolsu¹fonic acid into the corresponding hydroxy acids, thus elucidating their structure.[44] This led to a study of cresols. He made disulfonicbenzoic acid for the first time and from it prepared a new isomer of protocatechuic acid (which he called *α*-resorcyl acid) and isophthalic acid, verifying its structure.[45] Thus by making one of these compounds from another he arrived at a clear idea of their relationships, their constitution, and the positions of the substituent groups.

From the fusion of phenol and potash, Barth obtained a new class of compounds, the diphenols[46] ($(C_6H_4OH)_2$). He was also interested in condensation products. From dihydroxybenzoic acid in the presence of sulfuric acid he obtained tetrahydroxyanthraquinone,[47] which he called anthrachryson, and from *m*-hydroxy benzoic acid, anthraflavone[48] (dihydroxyanthraquinone) an isomer of alizarin, both of which are similar to rufigallic acid (1,2,3,5,6,7-hexahydroxyanthraquinone), and neither of which gives phthalic acid upon oxidation. It is now well known that hydroxybenzoic acids in which the hydroxyl group is meta to the carboxyl group form on heating the corresponding hydroxyanthraquinones.

IN VIENNA

The years 1875–76 brought important changes for Barth. Through the sudden death of Hlasiwetz and retirement of von Schneider from the University, two important positions were vacant in Vienna and Barth was sent for. While in Vienna considering this problem, he was informed of his wife's illness. She died before he could reach Innsbruck and, with mixed feelings, he accepted the appointment as Professor of Chemistry at the University of Vienna on August 9, 1876. With characteristic energy he undertook a thorough change in the organization of his department. A number of students were attracted to work under him and from the time of Barth's appointment until his death, not less than 170 papers were produced. With Goldschmidt he began the study of ellagic acid[49] (a dilactone of hexahydroxydiphenyl-2,2′-dicarboxylic acid), a constituent of many tannins, and noted its relation to gallic and rufigallic acids. It is now synthesized by regulated oxidation of gallic acid with arsenic acid.

In the fall of 1875 he took up with Schreder the difference in the reaction of potassium and sodium hydroxide on aromatic compounds. Three years before, they had noted that the course of reaction of benzoic acid was different when sodium hydroxide was substituted for potassium hydroxide.[50] A continuation of the work showed that sodium hydroxide promoted loss of carbon dioxide by acids,[51] and that the sodium hydroxide fusion of phenol produced very little diphenol but that phloroglucinol was produced in fair yield. This was the first synthesis of phloroglucinol. Using benzene trisulfonic acid, they replaced the three sulfonic acid groups with hydroxyl groups and again synthe-

[39] *Ann.*, **136**, 110 (1865).
[40] *Ibid.*, **152**, 96 (1869).
[41] *Ibid.*, **142**, 246 (1867); **159**, 230 (1871).
[42] *Ibid.*, **148**, 30 (1868).
[43] *Ibid.*, **119**, 266 (1861).
[44] *Ibid.*, **152**, 91 (1869); **174**, 235 (1874).
[45] *Ibid.*, **154**, 356 (1870); **159**, 217 (1871).
[46] *Ibid.*, **156**, 93 (1870); *J. Prakt. Chem.*, **19**, 22 (1879).
[47] *Ibib.*, **164**, 109 (1872).
[48] *Ibid.*, **170**, 100 (1873).
[49] *Ber.*, **11**, 77 (1878); **12**, 1237 (1879).
[50] *Ann.*, **164**, 138 (1872).
[51] *Ber.*, **12**, 1255 (1879); *Monatsh. Chem.*, **3**, 799 (1882).

sized phloroglucinol.[52] With von Schmidt he subjected dihydroxybenzene monosulfonic acid to potash fusion and obtained protocatechuic acid, thus replacing a sulfonic acid group by a carboxyl group for the first time.[53] They later discovered that sodium hydroxide and hydroquinone gave hydroxyhydroquinone, the third trihydroxy benzene, and very little pyrogallol and phloroglucinol.[54]

STRUCTURE OF BENZENE

In 1879, Max Gruber, then Barth's assistant, found that, by the reaction of nitric acid on protocatechuic acid, a new acid was formed which gave up carbon dioxide easily, yielding tartronic acid (hydroxymalonic $CHOH(COOH)_2$). He and Barth believed this acid to be tribasic and called it carboxytartronic, $H—O—C(COOH)_3$. Barth thought it improbable that the carboxy group had been cleaved in the process and therefore that the acid must have come from the benzene nucleus.[55] This meant that in the benzene nucleus one carbon atom was bound to three others. Consequently, from chemical evidence they came to the same conclusion as Julius Thomsen[56] had by thermochemical research, namely that Kekulé's ring formula for benzene must be abandoned and replaced by the prism formula of Ladenburg or another of similar linkage. Kekulé answered by upholding his ideas and later proved that the formula for the new acid must be $HOOC—(C(OH)_2)_2—COOH$ (2,3-tetrahydroxytartaric), as it could be prepared from tartaric acid, and therefore that the carbon atoms had normal linkage.[57] It should be noted that these two formulas differ by H_2O, Barth's formula being $C_4H_4O_7$ and Kekulé's $C_4H_6O_8$. At this time the Kekulé structure of benzene was a matter of great argument. Many organic chemists advocated the prism formula and Beilstein in the first edition of his handbook [page 1, Vol. II (1888)] mentions three equally probable structures of benzene.

In the year 1879 Barth was elected a member of the Vienna Academy of Science, having been since 1876 a corresponding member. He assisted the editor of *Monatshefte für Chemie* in the organization of material and preparation of an author and subject index, had a prominent part in the writing of a new edition of the Austrian Pharmacopeia, and was a member of the highest Sanitary Council of the Reich. Both he and Hlasiwetz published their work in the *Journal of the Vienna Academy of Science* and gave papers before this body. During the last few years of his life he suffered from a severe heart ailment and only his will power enabled him to follow his career. On August 3, 1890, he died.

[52] *Ber.*, **12**, 417, 503 (1879).
[53] *Ibid.*, **12**, 1260 (1879).
[54] *Monatsh. Chem.*, **4**, 176 (1883); **5**, 589 (1884).
[55] *Ibid.*, **1**, 869 (1880).
[56] *Ann.*, **205**, 133 (1880); *Ber.*, **13**, 1808 (1880).
[57] *Ibid.*, **221**, 230 (1883).

CONCLUSION

Hlasiwetz and Barth are representative of that great group of scientists who laid the groundwork for others. They discovered and identified many important compounds, and while reaching no brilliant theoretical conclusions themselves, their meticulous, intelligent investigations of plant pigments, roots, barks, and the substances obtained therefrom, gave an insight into the structure of these compounds which could be made use of by later workers. It is of interest to note that many classes of compounds investigated by Hlasiwetz were later taken up by Emil Fischer. The lives of Hlasiwetz and Barth were as well-ordered as their work and it is evident that the high regard in which they were held by their colleagues, and the number of students inspired by them, were the result of the example they set, as well as—or even more than—the ideas they propounded. Today, as always, chemistry needs men of their caliber—accurate, reliable workers with a deep-seated interest in the laboratory.

ACKNOWLEDGMENT

The study of the lives and work of these important chemists of the middle nineteenth century was undertaken at the suggestion of Dr. Clara de Milt.

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A SECONDARY-SCHOOL COURSE IN INORGANIC PREPARATIONS

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For several years we have capitalized on an exceptional interest in chemistry aroused in secondary-school students. A number of students are in school who have satisfactorily completed their elementary chemistry course, either on this campus or elsewhere. Some of these have program time available for a minor course in the senior year (grade 12), and wish to continue in chemistry. Approximately eight students each year, for several years now, have pursued such a course.

The course in inorganic preparations offered to these students is in no sense an attempt to anticipate their work in college. Rather, the course aim is to keep chemistry bright and interesting for later use in college courses. Scattered reports from students who have gone on to college show that in a modest measure at least, the course has been successful in fulfilling its purpose.

The course comprises one class period per week plus two consecutive hours in the laboratory. Most of the students are willing and even anxious to work more hours than are scheduled. To these, the laboratory is made available.

Class time is given to explanation of apparatus and its operation, techniques of operations to be performed, and the chemistry of the reactions involved in the preparations. Time is left for a systematic review of all sorts of numerical problems of elementary chemistry. The material on which these problems is based is selected from various sorts of work in elementary chemistry. Hence the problems furnish an excellent review of the text as well as of stoichiometry.

We have used with success the following texts:

Blanchard, A. A., J. W. Phelan, and A. R. Davis, "Synthetic Inorganic Chemistry," John Wiley & Sons, Inc., New York, **1936.**
Walton, H. F., "Inorganic Preparations," Prentice-Hall, Inc., New York, **1948.**

with occasional use of

Henderson, W. E., and W. C. Fernelius, "Inorganic Preparations," McGraw-Hill Book Co., Inc., New York, **1935.**

The experiments must be selected with care to include only those within the range of the apparatus available. Unlike a similar course given in grade 16,[1] we do not send students to source literature other than to THIS JOURNAL.

Further, students may substitute for this course a project that continues throughout the year. For example, for two years different students have worked on the problem of trying to find the molecular weight of *Hevea* latex when it is fractionally creamed by ammonium alginate solution. The method followed is similar to that described by K. Van Holde and R. A. Alberty.[2]

Several dozens of different preparations have been accomplished by students in recent years. They include the preparation of:

1. Chemically pure sodium chloride from common salt.
2. A double salt such as $Cu(NH_4)_2(SO_4)_2 \cdot 6H_2O$.
3. A complex salt such as $Cu(NH_3)_4SO_4 \cdot H_2O$.
4. Sodium perchlorate by neutralization.
5. Anhydrous magnesium chloride.
6. Boric acid and boric oxide from borax.
7. Chromium and other metals by a Goldschmidt reduction reaction.
8. Mercurous nitrate, mercuric nitrate, stannic chloride, ammonium chlorostannate $[(NH_4)_2SnCl_6]$, and titanic sulfate solution.
9. Nitrogen dioxide, sulfur dioxide, and chlorine in sealed tubes.

Students keep a log-type notebook. The object, sketch of apparatus, weight of yield, percentage of yield, and comments about the purity of the product are included in the notebook. Also logged are comments about the procedure, difficulties encountered, and the method used to surmount the difficulties.

Apparatus is sometimes improvised. A clay partition-tile insulated with aluminum foil and heated by a Bunsen burner served as a drying oven until we adapted a used domestic electric baking oven for this purpose. We also use a hand centrifuge, desiccators, suction funnels, and all of the equipment common to elementary chemistry. A gas-fired furnace was constructed from firebricks that once lined the firebox of a steam boiler. A constant-temperature bath is stirred by a blowpipe mounted in a chuck attached to a small motor. A student-made mercury thermoregulator is attached to the necessary relays and to an electric light bulb that heats the bath. A "T" connection and a shut-off valve placed in the steam line that supplies heat to a radiator in the laboratory makes steam available for steam baths. The jet of steam from this source has proved to be a valuable aid to loosen "frozen" glass stoppers. Ice is supplied by nature, and from the cube trays of a domestic refrigerator when the natural supply fails.

The compounds made by the students are sealed in small jars which are properly labeled, including the student's name. These products make a colorful dis-

[1] Gayer, K. H., and M. J. Elkind, "A course in inorganic preparations," J. Chem. Educ., **30,** 90 (1953).

[2] J. Chem. Educ., **26,** 151 (1949).

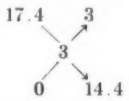
play in the corridor. We have sometimes added a picture of the student at work in the laboratory.

Students like to make a tangible product. They have reason to be proud when they have learned to prepare a hydrated salt that while dry lacks the evidence of efflorescence, that is well crystallized, and that gives negative results when tested for impurities.

On the other hand, students do not generate much enthusiasm for the problem work of chemistry—with one notable exception. They seem to admire greatly the method for solving mixture problems that is called Pearsons' square. Since Pearsons' square (certainly not original with the writer) is not mentioned in the 25-Year Index of THIS JOURNAL, two examples of this time-saving method are given here.

(1) *Problem:* Concentrated acetic acid is 17.4 *N* as purchased. What volume of acid is needed to make one liter of 3 *N* solution?

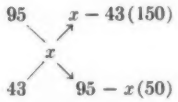
Solution: Place the given concentration and the acid concentration of water (0) on the left side of a square pattern. Place the wanted concentration in the center of the square. Subtract arithmetically along the diagonals of the square, thus:



The acid to water ratio is 3 to 14.4 or 1 to 4.8. That is, of 5.8 parts of liquid, one part is acid. 1000 ml./5.8 gives 173 ml. of acetic acid.[3]

(2) *Problem:* If 150 ml. of 95 per cent sulfuric acid is mixed with 50 ml. of 43 per cent acid, what is the per cent of acid in the mixture?

Solution:



The ratio of $(x - 43)$ to $(95 - x)$ is the same as that of 150 ml. to 50 ml. Hence x equals 82 per cent.

In at least one secondary school, chemical research is carried out that results in papers acceptable to the *Journal of the American Chemical Society.* While such a situation appears to be an unusual case, a course in inorganic preparations is well within the range of many another secondary school. The interest of several secondary and junior-college teachers in this minor course suggests that a similar course offered elsewhere may find ready acceptance. Student interest in the course as conducted here is high. Indeed, it serves as a stimulus to some of the students in elementary chemistry, one of whom is now doing a few of the advanced experiments as an extra-curricular project.

[3] This answer agrees substantially with that given in the "Handbook of Chemistry and Physics," 32nd ed. Chemical Rubber Company, **1951,** p. 1415.

DEMONSTRATION OF THE INTERMEDIATE POSITION OF COBALT BETWEEN IRON AND NICKEL

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THE different oxidizability of ferrous, cobaltous, and nickelous hydroxides, together with the increasing color deepness of the oxidation products, can be used to demonstrate that cobalt is intermediate in its properties between iron and nickel.

(*1*) *Iron.* Take a solution containing Fe^{++} ions and add a solution of alkali hydroxide. The white precipitate of $Fe(OH)_2$ formed at first is almost instantaneously oxidized by air, converting it into reddish-brown $Fe(OH)_3$, no additional oxidizing agent being required.

(*2*) *Cobalt.* Precipitate in the same way a solution containing Co^{++} ions. A blue basic hydroxide is formed, changing very soon to pink colored $Co(OH)_2$. This hydroxide is very slowly oxidized by air to the dark brown $Co(OH)_3$, but immediately by hydrogen peroxide.

(*3*) *Nickel.* A solution containing Ni^{++} ions gives with alkali hydroxide solution an apple-green precipitate of $Ni(OH)_2$, not oxidized by air or hydrogen peroxide. Oxidation to the black nickelic state can be brought about through the addition of bromine.

SUGGESTIONS FOR TRANSLATING GERMAN, FRENCH, AND ITALIAN CHEMICAL LITERATURE[1]

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THE object of this paper is to outline briefly some of the major problems facing the translator of foreign chemical texts, and to offer a few practical suggestions for solving them. The intention is not to lay down any ironclad rules which will apply in *all* cases, but rather to recommend a few simple mental techniques calculated to facilitate the work of the chemist who may be called upon to translate from the foreign literature.

Before embarking upon a discussion of specific translating procedures, a few words about the principles of technical translation in general might serve as an introduction to the subject. The primary principle of good technical translating is to translate ideas and not words. In translating scientific as distinct from literary material, forms of words are not an end but a means—admittedly an imperfect means—for transmitting the ideas from the mind of the foreign author to that of the English-speaking reader. If the foreign author's expression of these ideas is deficient or otherwise lacking in clarity, it is the duty of the translator to disentangle the author's possible intended meanings and subsume them within an acceptable English rendition.

It has been said before, and it is worth repeating here, that a technical translator must combine three faculties:

(1) He must have a fairly extensive knowledge of, and be able to reason in, the subject matter of the translation—in our case, chemistry.

(2) He must be able to read the language he is translating well enough so that he can grasp the author's intended meaning, even if poorly expressed.

(3) He must himself be able to embody that meaning in lucid and straightforward English.

Because of the principle that ideas rather than words should be translated, style is somewhat of a secondary consideration, except to the extent that it should always be appropriate to the subject matter at hand. Generally speaking, in technical English it is advisable to prefer the concrete word to the abstract, and the active and transitive verb to the passive and intransitive.[2] A whole book could—and should—be written on the principles and problems of technical translation. Here, I shall select but a few of these problems for comment.

[1] Presented at the 122nd Meeting of the American Chemical Society, Atlantic City, September, 1952.

[2] As Quiller-Couch has pointed out in his "The Art of Writing," published in 1928.

COGNATES

Recognition. It is my belief that the ability to recognize English cognates of foreign technical terms greatly facilitates the translation of technical material for anyone who is faced with a foreign text in his own field of specialization. Chemists who write in German, French, and Italian—the only languages which will be considered here—are not only professional colleagues whose minds are likely to work along the same scientific lines as that of an American chemist, but they are also to some extent terminological brothers under the skin. This is more or less true of all fields of science, where specialized terminology has been evolved in one country and just as quickly adopted in another. Technical terminology generally keeps pace with scientific discovery, and as the results of individual and original research become known so do the new terms used to describe this research. Of course, by the time they reach us many of these terms have already been anglicized. Familiarity with a few basic principles enabling one to spot cognates automatically, as it were, will obviate the need for much time-consuming word hunting in the many instances where the English cognates can be detected at a glance. The examples given below are not always applicable, and there are a number of linguistic pitfalls to be avoided—cases where apparent cognates can turn out to be "false friends."

Perhaps the most useful aid in recognizing cognates is a knowledge of the vowel and consonant changes which tend to recur frequently. The following enumeration of such changes makes no pretense at completeness, and although the cases illustrated will not be applicable always, they will be helpful in most instances.

The consonants **b,** and **f, v,** or **w** are sometimes interchangeable. Thus, the German word *Si**l**ber* is cognate to sil**v**er. *Wismuth*, on the other hand, is **b**ismuth. In German, the letter **b** will often reveal an English cognate when changed to **f,** as in *ha**l**b* meaning ha**l**f.

In Italian, the letters **c, ch,** or **cc** will often hide a cognate. Thus, *ca**o**lino* is **k**aolin, *e**cc**ipiente* is e**x**cipient, and ***ch**inino* is **qu**inine. In German, the letters **ch** will frequently become **qu**, as in ***Ch**inaldin* (**qu**inaldine) and ***Ch**inol* (**qu**inol). In French, **ch** is also sometimes equivalent to **qu,** as in ***ch**inoline* (**qu**inoline).

At this point I might mention that the letter **k** does not exist in Italian, except in a handful of foreign words—mostly proper names. For example, one of the standard Italian dictionaries, somewhat like the

French "Larousse," contains roughly 120,000 entries, but only about 50 of these appear under the letter **k**. Since **ch** in Italian is generally pronounced **k,** such Italian words as ***chilometro*** and ***chilogramma*** are cognate to the English words **k**ilometer and **k**ilogram.

Therefore, when confronted with a word containing the letters **ch,** one should mentally allow for the possibility that there is an English cognate where these letters will have changed to **qu** or **k.** As often as not, however, the English will also be written with **ch,** but then there is no problem because the cognate is overt and not hidden.

The combination **cl** or **cr** in Italian will often stand for **chl** or **chr** in English, as in *cloro* (**chl**orine) and *cromo* (**chr***omium*).

Conversely, English words written with a **c** will often be cognate to German words written with a **k,** as in ***kolloidal*** (colloidal), ***Koks*** (coke) and ***kalorisch*** (caloric). German words ending in **cht** are generally cognate to English words ending in **ght,** as in *Licht* (li**ght**) and *Fracht* (frei**ght**).

The thing to remember, therefore, is that the letters **c, ch, qu, k,** and **gh** are to a large extent interchangeable, and when confronted with a word containing any of these consonants one should be mentally prepared for the change.

With regard to the letter **d,** in cognate words it corresponds to German **t** or **th,** as in ***Tochter*** (daughter) and ***Tod*** (**d**eath). This latter example shows that, conversely, German **d** is sometimes cognate to English **th,** as also in *Bru**d**er* (bro**th**er).

When faced with a foreign word containing the letter **f,** especially in Italian, the English cognate (if there is one) will immediately come to mind if the **f** is mentally changed to **ph,** as in *fenolo* (**ph**enol), *asfalto* (as**ph**alt), and a less obvious example, because it contains a double consonantal change, *canfora* (cam**ph**or). In cognate words, English **f** may also correspond to German **v,** which is understandable if one remembers that in German the letter **v** is pronounced **f.** Here are two examples: ***Vater*** (**f**ather), ***vorwärts*** (**f**orward).

A single or double **g** in Italian will often give a clue to the English cognate when the **g** or **gg** is changed to **j** or **dj,** as in ***getto*** (jet) and ***aggiustare*** (a**dj**ust).

Although the letter **h** does exist in Italian, it exists only as an expedient in writing to differentiate between two words which are identical in pronunciation but dissimilar in meaning (as between *anno,* year, and ***hanno,*** they have), or else as part of a consonantal group such as **ch** or **cch.** In Italian, the letter **h** has no consonantal standing of its own. When it occurs by itself, other than in such cases as just illustrated, it is as part of a foreign word, proper name or place name. The standard Italian dictionary mentioned earlier lists only about 80 words under the letter **h.** This therefore presents a problem since a large number of Italian words will be recognized as cognates only if an **h** is mentally added. First of all, there are all the words containing such radicals as **hydro** and **hypo,** which in Italian will appear as *idro* and *ipo.* For example, rather than reach for the dictionary, supply an **h** in such words as *alcool* (alco**h**ol), *idrato* (**h**ydrate), *iposulfato* (**h**yposulfate), *aldeide* (alde**h**yde), *idrolisi* (**h**ydrolysis).

The last four examples conveniently bring us to the vowel **i.** In Italian, this vowel can probably hide more cognates than any other single letter. Since Italian does not have the letter **y** at all, countless Italian words with **i** are direct cognates to English words written with **y.** The example of *idrolisi* (hydrolysis) is especially revealing because both the first and second **i** change to **y.** The same is true of *idrossile* (hydroxyl). Here are two more examples of this change: *acetile* (acetyl), *amile* (amyl). Therefore, when an Italian word with an **i,** either at the beginning or in the middle of the word, is suspected of being a cognate, the assumption can often be turned to certainty by mentally substituting a **y** or **hy** for the **i.**

The letter **j** in English presents no problem in French to which it is cognate. Nor does it present a problem in Italian for the very good reason that it simply does not exist in that language. In German, however, the **j** is sometimes cognate to our **y** or **i,** as in *Jahr* (year), *Jodid* (iodide) and *Jon* (ion).

The letter **k** was discussed above in connection with **c, ch,** and **qu,** and the letter **l** is generally cognate in the foreign. **M** and **n,** however, are sometimes interchangeable when preceding **f** and **ph.** We have seen that the English cognate of the Italian word *canfora* is cam**ph**or. The same is true of French where, for example, the word *confort* is cognate to com**f**ort.

The vowel **o,** notably in French and Italian, may be cognate to **u,** as in *fonction* (f**u**nction) and *pompa* (p**u**mp).

In German, **pf** is cognate to English **p,** as in *Ho**pf**en* (ho**p**s) and *Tro**pf**en* (dro**p**s).

Since the consonants **q** and **qu** have already been discussed and since the letter **r** generally presents no problem, we now come to the letters **s, t,** and **z** which do.

In Italian, the double **ss** is almost always cognate to our **x,** as in *complesso* (comple**x**), *ossido* (o**x**ide), and re*flusso* (reflu**x**). When it precedes **p,** the Italian **s** also becomes **x,** as in *espansione* (e**x**pansion). In German and French words containing the letter **s,** the **s** generally remains unchanged in the English cognates.

The letter **t** in Italian can also be an annoying but, as we shall see, transparent screen behind which a perfectly good English cognate will lurk, especially when one **t** combines forces with another. Take the word *ottano* (o**ct**ane), or the words *elettrico* (elec**t**ric), *effetto* (ef**f**ect), *contatto* (con**t**act). As is evident, the double **tt** becomes **ct.** Here is one case where it becomes **pt:** *settico* (sep**t**ic).

Since the letter **h** in Italian is merely an auxiliary and does not have any standing of its own, as we have seen, it is reasonable to expect that English words with **th** will, when we meet them in Italian, have lost the **h** en route. Such Italian words will read like perfect English if the **h** is restored in its familiar place behind the **t,** as in *catodo* (ca**th**ode) and *metano* (me**th**ane), or,

for those who prefer a somewhat more challenging mental exercise, here is an example of another double change: ***etile*** (**ethyl**), in which the **t** becomes **th** and the **i** becomes **y**.

This being our last example of vocalic and consonantal changes in Italian, I have selected the Italian name of a chemical compound which requires seven letter changes before it becomes recognizable in English, namely, *esaossicicloesane*. By restoring the two missing **h's**, changing all the **s's** to **x** and all the **i's** to **y**, we finally get: **hexaoxycyclohexane**, or, of course, hexahydroxycyclohexane.

In French and German, the letters **t** and **th** are a help rather than a hindrance in recognizing cognates, except that occasionally one will find an extra **h** after the **t** as a form of antiquated spelling in German, as in *Theil* for *Teil* (part).

With the letter **z** we fittingly come to the last of the changes selected for illustration. Here, the difficulty is in connection with the **z** in German, which may become **c** or **s** in the English cognate, as in *Kalzium* (calcium) and ***Zucker*** (sugar).

Those who agree that translating is made easier if one becomes proficient at the game of "cognate-hunting" (or, if you prefer, at the practice of mnemonics) may find the accompanying table of value. This

Table of Cognate Correspondences

German	*French*	*Italian*	*English*
b			v or f
		c	k or ch
		cc	xc
ch	ch	ch	k or qu
cht			ght
d			th
		f	ph
		g	j
		gg	dj
		i	y or hy
j			y or i
k			c
	n	n	m
	o	o	u
pf			p
		s or ss	x
		tt	ct or pt
t			d
v			f
w			b
z			c or s

table is far from complete. It is merely a guide and includes only some of the many possible vocalic and consonantal shifts which occur in German, French, and Italian words as compared to their English cognates. By and large, the letters listed will change only occasionally as indicated; where they do not change, the cognate letter is generally the same, and the word therefore presents no problem.

Phonetic Versus Etymological Spelling. The reason for all these divergent spellings of cognate words in various languages is that some languages have adopted etymological spelling and others phonetic spelling. Dr. K. A. Jensen of Copenhagen dealt with this question in the paper[3] which he delivered at the A.C.S. Meeting in New York in 1951. He rightfully pointed out that in the last century most philologists were of the opinion that the written language should, as far as possible, be a phonetic rendition of the spoken language. But since languages differ from one another in pronunciation, and since the phonetic value of a given letter is not always the same in different languages, the adoption of phonetic spelling has tended to isolate these languages from each other. An alternative to phonetic spelling, so certain modern philologists contend, is etymological spelling, in accordance with the derivation from a parent language, such as Latin or Greek. Phonetic spelling tends to vary from language to language, whereas etymological spelling will generally be constant. Most of the changes discussed above are due to the fact that cognates are spelled differently in various languages for phonetic reasons. Therefore, a very important asset to anyone who is called upon to translate from the foreign is a knowledge, however rudimentary, of how the words in the particular foreign language are pronounced. I would consequently recommend that those who are interested in translation spend some time familiarizing themselves with the pronunciation of the language concerned.

FALSE FRIENDS

Now a word of caution which should dampen anyone's excessive enthusiasm for cognate-hunting. There are many words, especially in the Romance languages, the spelling of which so closely resembles that of certain English words that one may be tempted to translate them literally. Although similar in form, these words are frequently different in meaning, and the chances are against any passage being correctly translatable by simply substituting the apparent—but false—cognate. This is an important pitfall to avoid, and such "false friends," as professional translators call them, should never be taken at face value.

This problem is particularly acute when translating from French. A considerable number of French words have found a secure place in the English language in almost unchanged *form*. However, the *meaning* of some of these words has evolved along different lines, so that a word which crossed the English Channel at the end of the eleventh century, let us say, and had the same meaning on both sides of the water at that time, may have a different meaning today.

The phrase, "*cette* ***expérience*** *a été d'****intérêt,***" contains two false friends. It does not necessarily mean "this experience was of interest," although in some contexts it may. In technical, and especially in chemical texts, it means, "this **experiment** was **useful**" or "this **experiment** was **of value,**" or even "this was a **significant experiment.**" Another example: "*Cette réaction a* ***pratiquement*** *donné du cuivre*" does not indicate that the "reaction practically yielded copper," but rather that it yielded copper "in practice," or more smoothly rendered, "this reaction **actually** yielded copper."

[3] "Problems of an international chemical nomenclature."

Another French word which should not always be translated literally, especially in technical texts, is the word ***important.*** In addition to its obvious abstract meaning of "important," it also has the concrete meaning of "large" or "**substantial,**" as in this example: "*Nous avons obtenu une quantité* ***importante*** *de l'acide,*" which should correctly be translated as, "we obtained a **substantial** quantity of the acid." Here are two more French words which should be carefully interpreted on the basis of the context: "*une* ***lecture***" is not "a lecture," but "a **reading.**" "***Sans doute***" may mean "without doubt," but more often it means just the opposite, namely, "**probably**" or "**perhaps.**" You can readily see how a translation of the phrase, "*ne me dérangez pas!*" would be somewhat lacking in accuracy were it rendered as "do not derange me!" Translating from French presents many such pitfalls.

You will also encounter a number of false friends in German, although less frequently so. I have selected a few examples which may be regularly found in technical texts. The expression, "*Technische* ***Hochschule,***" does not, all appearances to the contrary, mean "technical high school." It stands for "**institute** of technology" or "polytechnic institute." In German, a "*Hochschule*" is a university. Another false friend in German is one which all of us have warmly embraced at one time or another. I am referring to the word ***eventuell.*** Neither in its adjectival nor in its adverbial form does it mean "eventual" or "eventually." In German, this word denotes contingency in the sense of our own noun "eventuality." According to Webster, the corresponding English adjective and adverb originally had the same meaning, but this meaning is now obsolete. In German, the word *eventuell* can variously mean, "if necessary," "in certain cases," or just "perhaps." Let me illustrate: "*Diese Ergebnisse werden* ***eventuell*** *veröffentlicht werden*" does not mean that the "results will eventually be published," but rather that they "**may** be published" or that they will "perhaps" be published.

The words ***neben*** and ***durch*** are two more examples of words which should not be taken at face value. Although *neben* can mean "next to," it is often preferable to translate it as "**in addition to.**" The word "*durch*" may have to be translated as "through" in some contexts, but in others it is more properly rendered as, "**by**" or "by means of." Thus, "*durch Erhitzen,*" is not "through heating," but "by heating." "***Carbonsäure***" is another case in point. It is properly rendered as "**carboxylic acid**" not "carbonic acid," which in German is "*Kohlensäure.*"

PREFIXES AND SUFFIXES

A less elusive subject is that of prefixes and suffixes. I have selected a few typical ones in German, French, and Italian, and shall indicate their English equivalents, which may sometimes be cognate, but just as frequently not.

In German, the prefix ***unter-*** often becomes **hypo-, sub-,** or **infra-,** in addition to the more obvious **under-,** as in the following examples: ***unter****phosphorig* (**hypo**phosphoric), ***Unter****einheit* (**sub**unit), and ***unter****belichten* (**under**expose). The antonymic prefix ***über-*** can become **per-, super-** (or **supra-**), **hyper-,** and **ultra-,** in addition to **over-.** Sometimes, it must be rendered by the word "**excess**": ***Über****oxyd* (**per**oxide), ***über-****basisch* (**super**basic); ***über****elastisch* (**hyper**elastic), ***Über****mikrometer* (**ultra**micrometer), ***über****laufen* (**over**flow, or flow **over**), ***Über****hitze* (**excess** heat).

A useful rule to remember is that, generally but by no means always, ***über*** in chemical compounds is **per-** and in verbs **over-.** Conversely, ***unter-*** is **hypo-** in chemical compounds and **under-** in verbs.

The French and Italian prefixes corresponding to those mentioned are fairly easy to identify and need not be discussed. The same is true of the Romance-language suffixes ***-able, -ible,*** and ***-uble*** (in French) and ***-abile, -ibile,*** and ***-ivile*** (in Italian). These correspond to the German suffix ***-bar,*** which, in English, is generally **-able, -ible,** or **-uble.** For example, German *haltbar* equals French ***stable*** and Italian ***stabile*** (English: st**able**).

The corresponding nouns—that is, those which in English end in **-ity** (*e. g.*, stabil**ity**)—as a rule have the following endings in the other three languages: German, ***-keit*** (as in, *Beständig****keit***); French, ***-ité*** (as in, *stabili****té***); and Italian, ***-ità*** (as in, *stabili****tà***).

A chemical suffix which may be difficult to equate is ***-ure*** in French and ***-uro*** in Italian. These suffixes denote a salt and are rendered as **-ide** in English (*e. g.*, *chlor****ure*** or *clor****uro*** is chlor**ide**).

In the introduction to his invaluable "French-English Dictionary for Chemists,"[4] Dr. Austin M. Patterson mentions some very helpful hints for the translation of organic compounds from French, where the prefix or suffix is the key to the correct translation. I quote them here, with his kind permission, because as a rule they also apply to Italian.

(1) Translate *oxy-* by **hydroxy-** when it designates hydroxyl, as is commonly the case in organic names. When *oxy-* designates the ketonic group (CO) it is preferably translated **oxo-** or **keto-.**

(2) Translate names of compounds the chief function of which is alcoholic or phenolic so that the name ends in **-ol;** as, glycerol, resorcinol, mannitol, pinacol (not pinacone).

(3) When the French ending *-ol* does not indicate hydroxyl it should be translated **-ole** (as, anisole, indole), or in the case of a few hydrocarbons **-ene** (as *benzol,* benzene; *toluol,* toluene; *styrol,* styrene).

(4) The ending *-ine* or *-in* should be translated **-ine** in the case of basic substances and **-in** elsewhere; as, aniline, glycine, palmitin, albumin. Exceptions are *benzine* (meaning benzene) and the names of alcohols and phenols (see (2)).

(5) The form *amido-* should be so translated only when it denotes combination with an acid group. Usually it is to be translated **amino-;** as, *acide amido-*

[4] John Wiley & Sons, Inc., New York.

proprionique, aminoproprionic acid; *amidophénol*, aminophenol. The same holds for imido-, anilido-, etc.

(6) In such combining forms as bromo-, cyano-, chloro-, nitro-, etc., when they denote substituting radicals, the connective **o** is to be used invariably; as *chlorobenzène* or *chlorbenzène*, chlorobenzene; *acide chloracétique*, chloroacetic acid. This usage is by no means universal, but those who cannot reconcile themselves to such spellings as "bromoacetic" should at least avoid the German forms bromphenol, acetphenitidine, etc., by using the connective **o** before consonants. (French literature does not contain so many of these objectionable forms as does the German.)

(7) The French ending *-ane* should be translated **-ane** if it is the name of a hydrocarbon (or parent heterocyclic compound) which is *fully saturated*; otherwise, **-an.** Examples: methane, menthane, tolan, furan, pentosan.

(8) Names of acids ending in *-carbonique* are translated **-carboxylic,** not -carbonic.

MISCELLANEOUS

Inversions. We now come to the question of inversions, which are characteristic of French and Italian, and which may present somewhat of a problem. Although in German the adjective generally precedes the noun, as is usually the case in English, this is not true of French and Italian where, as a rule, the adjective follows. Here are some examples: *une solution* ***concentrée*** (a **concentrated** solution), *acide* ***nitrique*** (**nitric** acid), *nel campo* ***speciale*** (in the **special** field), *carbonato* ***sodico*** (sodium carbonate), etc.

From where the English translator sits, French and Italian invert the words in chemical compounds, occasionally connecting them with the preposition **of,** *i. e.*, *di* in Italian and *de* in French. By reading them in inverted sequence, and forgetting about the preposition, the English equivalent immediately becomes apparent. For example, *bromure* ***de*** *calcium* (calcium bromide), *acide* ***de*** *tartre* (tartaric acid), *acetato* ***di*** *alluminio* (aluminum acetate), *bagno* ***di*** *olio* (oil bath), etc. In certain cases, however, the cognate is not as easily detected, even after the inversion has been mentally made. Thus, *acide chlor****hydr****ique* (**hydro**chloric acid), *aldeide* ***formica*** (**form**aldehyde). By locating the **hydro** radical—or, as a colleague once put it, "looking for the hidden water"—in the foreign name of the compound, one can often translate it at a glance.

The fact that the French and Italians call "sodium chloride" *chlorure de sodium* and *cloruro di sodio* explains why one will occasionally find equations where NaCl appears as *ClNa*. This is true of so many compounds that some chemical equations in French and Italian often look as if someone just jumbled all the chemical symbols.

Another thing worth remembering is that when an adjective following two or more nouns is in the plural, it applies to all the nouns and, in English, should therefore precede *all* the nouns, not just the last. For example, "*à une température et une pression* ***élevées***" means "at a **high** temperature and pressure." Likewise, "*acido nitrico, sulfurico, e idrofluorico* ***concentrati***" means "**concentrated** nitric, sulfuric, and hydrofluoric acids."

Such inversions as generally occur in French and Italian may occasionally also occur in German, especially in a composite word designating a chemical compound in which the basic element is at the end. When translated, the elements must be inverted, as in *Kohlen****wasserstoff*** (**hydro**carbon), *Tetrachlor****kohlenstoff*** (**carbon** tetrachloride), *Schwefel****kohlenstoff*** (**carbon** disulfide), *Chlor****wasserstoff*** (**hydrogen** chloride), etc.

Inversions such as the above also extend to dates. When, in a foreign text, you see *6.2.52*, what is meant is February 6, 1952, not June 2, 1952.

Compound Words. At this point I cannot escape mentioning a few basic characteristics of German compound nouns and compound verbs. As you know, German—especially scientific German—has many compound nouns. Since their number is practically unlimited and since most are not listed in dictionaries, translators find it helpful to remember the basic words in the compound noun rather than the compound noun itself.

The question of German compound verbs is not quite as simple. Many of them are formed by a simple verb with a prefix, as for example *dampfen* (to steam) and ***ver****dampfen* (to evaporate). Some of these compound verbs are "separable" and some are "inseparable," that is, in the case of the latter the prefix is not separated from its basic verb, while in the case of the former it often is. In ordinary sentences containing separable verbs, the prefix appears at the end, as for example in "*der Inhalt siedet* ***über***" (the content is boiling over), "*der Schwefel nimmt an der Reaktion* ***teil***" (the sulfur participates in the reaction), etc. In subordinate clauses, however, verb and prefix reunite at the end of the sentence, as for example in "*der Verfasser berichtet dass der Schwefel an der Reaktion* ***teilnimmt***" (the author reports that the sulfur participates in the reaction).

Here I should like to draw your attention to an important warning. Very often a compound verb in German will have a different meaning than the basic verb in the compound. Before beginning to translate, therefore, one should *always* look at the end of the sentence or clause to see whether there is a prefix, as the prefix may determine the meaning. For example, in the sentence, "*die Temperatur nahm im Gefäss* ***ab***" (or ***zu***), there is no way of knowing whether the temperature **de**creased or **in**creased if one does not read to the end of the sentence. A somewhat similar phenomenon also exists in English, where compound verbs may have different meanings, depending on where the verbal component is placed with reference to the preposition. Thus, "to **over**sleep" is hardly the same thing as "to sleep **over**" and "to look something **over**" is definitely not the same thing as "to **over**look it."

Position of Verb. A few words about the position of the verb in German sentences might be in order here. The verb does not occur at the end of the sentence quite as persistently as Mark Twain would have us believe. Of course, when it does occur at the end of the sentence, it is often flanked by two or more verbal assistants, especially where the sentence has a number of subordinate clauses. What is generally not realized is that if the sentence begins with the subject, the position of the verb is the same as in English: "*das Gas* ***strömte*** *aus dem Röhrchen*" (the gas flowed out of the tube). If the sentence does not begin with the subject, the verb comes immediately before the subject: "*im Versuch* ***strömte*** *das Gas aus dem Röhrchen*" (in the experiment the gas flowed out of the tube). A notable exception to this rule is that in subordinate clauses the verb appears at the end of the sentence: "*Der Verfasser sah das Gas aus dem Röhrchen* ***strömen***" (the author saw the gas flow out of the tube).

Demonstrative Pronoun. In all the three languages here discussed, a sentence may often begin with a demonstrative pronoun referring to one or several nouns in the previous sentence. These pronouns (*dieser, diese,* or *dieses* in German; *celui-ci, celle-ci,* or *ceux-ci* in French; and *questo, questa,* or *questi* in Italian), whether in their masculine or feminine form, translate as either **this** or **these,** since the English pronoun does not have the corresponding genders. Therefore, unless it is perfectly clear which principal of the previous sentence is meant in English, it is often preferable to replace the pronoun by the actual noun or nouns to which the foreign pronoun refers.

In closing, let us briefly consider the question of accents, the decimal point, punctuation in figures, and abbreviations.

Accents. Accents in French and Italian, as well as in other languages, often have more than a phonetic function. In German, the umlaut is not an accent but a diacritical mark which changes the vowel over which it appears. Certain words will have different meanings depending on whether they are written with or without accent or umlaut. Here are a few examples:

In German, the verb *fordern* means to demand or to claim; with the umlaut, *i. e., fördern,* it is an entirely different word meaning either to promote or to convey. In French, the noun *cote* means quota or quotation; with the circumflex accent, *i. e., côte,* it means slope, coast or rib; if in addition to the circumflex accent over the *o* there is also an acute accent over the *e, i. e., côté,* the word means side. The word *ou* without an accent is the conjunction **or,** and with an accent, *i. e., où,* it is the adverb **where.** In Italian, the letter *e* without an accent means **and;** with a grave accent, *i. e., è,* it is the verbal form of "to be" and means **is.**

The Decimal Point. The decimal point in almost all foreign languages is not a period but a comma. When a German, French, or Italian chemist writes that he added *18,050* grams to a solution in a test tube, needless to say that he does not mean that "eighteen thousand and fifty" grams were added, but that 18.050 were added; conversely, where we use a comma to set off every thousand group in a figure, the foreign language will generally use a period. Thus, *18.050* g. is *not* eighteen grams and fifty milligrams, but 18,050 g. Sometimes, the custom is to use no punctuation at all to set off each thousand group, but merely to leave a space, like this *18 050.* In some German texts one may find a raised period to indicate the division, *i. e., 18·050.*

The Percentage Sign. The percentage sign in the foreign is generally the same as in English, *i. e.,* % or, as acceptable variants, *per* 100, *pour cent, per cento* or even *o/o.* None of these present any particular problem, but what does are such signs as ‰ and *o/oo* to indicate **per mill.** In such cases, it is often desirable to convert into per cent. For example, "*Abbiamo usato soluzioni al 1% e al 1‰* (or *al 1 o/oo*) *dei sali*" should preferably be rendered as: "We have used 1% and **0.1**% solutions of the salts." Therefore, *1‰* should be converted to 0.1% and *1‱* to 0.01%.

Abbreviations. We now come to the problem of foreign abbreviations, and a considerable problem it is, because the abbreviations used are sometimes of the author's own invention (in which case, the best we can hope for is that the context will indicate what they represent), and because they may, moreover, be of a local nature (either limited to a fairly small geographical area, or to a rather restricted field or industry).

When abbreviations consist of several capital letters, one should mentally be prepared to invert the letters, as this may occasionally provide a clue. Thus *DML* (*i. e., dose minima letale*) is MLD (minimum lethal dose); *S.N.C.* (*i.e., système nerveux central*) is C.N.S. (central nervous system); etc. Foreign authors do not appear to adhere to any uniform or standard set of abbreviations for weights and measures. French and Italian texts present the most flagrant evidence of this lack of uniformity. Thus, to indicate cubic centimeters (cc.), we may find such a variety of abbreviations as *cm³, ccm., cc.m., cm. cube* (or *cm. cubico*), *%m³,* and occasionally even *cc.* The varieties of abbreviations for milligram (mg.) reflect an even more fertile imagination. At one time or another I have encountered: *mm.g., mm.G., mmg., mmG., mmgr., mmGr., mm/G., G/mm* (which should indicate "grams per millimeter," but not always does), and even *‰ g.* Where there are several possibilities, the context will have to be relied upon to determine the correct meaning of the abbreviation. An interesting set of abbreviations, found in German, is: ***Jato*** for *Jahrestonnen* (tons per year); ***Moto*** for *Monatstonnen* (tons per month); and ***Tato*** for *Tagestonnen* (tons per day).

This completes my brief outline of the problems involved in technical translation. I fully realize that it is very incomplete, even as an outline. But the best I could hope to do was to present some of the highlights, and to offer a few practical suggestions.

A HIGHLY ACCURATE, RAPID-ACTION, MICRO OR MACRO BURET

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A BURET which may be used for very rapid titrations and which, at the same time, operates with exceptionally high accuracy was desired by the author for certain kinetic studies. The buret described has answered both of these qualifications. In addition it may be built with micro or macro dimensions, or it may be used for the dispensing of liquids unstable in the atmosphere. Once put into use it needs little attention over long periods of time. It is useful only for routine titrations, however.

The buret embodies the principle of replacement of the solution by a volume of dry mercury measured in a graduated buret barrel. Since a number of mercury burets have been described in the literature, the author is not at all certain of the extent of originality of the design presented in this paper.

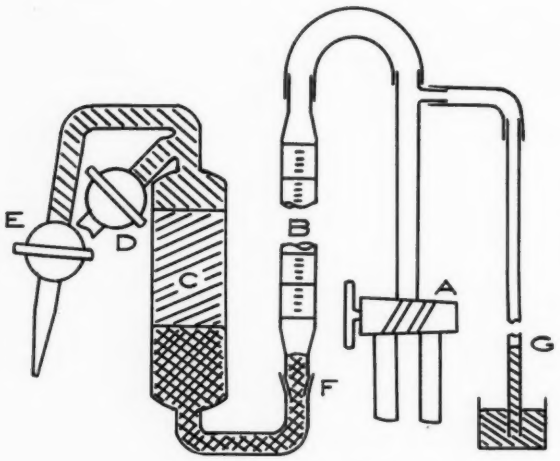

Figure 1. The Complete Buret

A, 3-way stopcock leading to a vacuum source and the atmosphere; *B*, calibrated buret barrel; *C*, reservoir tank containing mercury and *o*-dichlorobenzene topped by the standard solution; *D*, inlet for the standard solution; *E*, titration outlet; *F*, ground glass joint; *G*, manometer.

The drawing of the buret (Figure 1) shows the details of construction. Stopcock *A* leads either to a vacuum pump or to the atmosphere and is connected to the graduated barrel *B* by a length of desulfured rubber or Tygon tubing. The graduated barrel is attached to tube *C* by a standard-taper joint at *F;* this allows different barrels to be substituted without otherwise disturbing the apparatus. The buret as shown is for use with standard sodium thiosulfate. Since this reagent attacks mercury, presumably with formation of mercury sulfides, the solution is protected from the mercury by a layer of *o*-dichlorobenzene. This liquid was chosen because of its relative availability, its high density, its insolubility, and its inertness. The layer of *o*-dichlorobenzene should be of sufficient thickness to protect the mercury from contact with the wetted sides of tube *C*. Stopcock *D* is provided for intake of the standard solution from a reservoir and stopcock *E* for the outlet. Since these stopcocks are subjected to pressures of one atmosphere for short intervals, it is important to use pressure stopcocks and a grease of high consistency. Silicon high-vacuum grease is satisfactory since the tendency of this grease to creep does not affect the efficiency of the buret.

Only very pure mercury should be used. If the mercury contains substances which are easily oxidized, the calibrated barrel will become coated with metal oxides and require cleaning at regular intervals. With pure mercury the buret need not be disassembled for long periods of time. It is advisable not to allow the mercury to stand in the calibrated part of the buret when it is not in use. The only attention required by this apparatus is to regrease the stopcocks as needed. This is easily done without draining the standard solution.

Tube *C* should be about three times the volume of the calibrated barrel *B*, and the size of the latter is dependent only on the requirements of the user. Burets of 40-ml. and 5-ml. capacities have been used in this laboratory with results of equal accuracy; much smaller burets also should be accurate. The advantage of the design is particularly evident when the capacity is small.

The buret is extremely rapid. Since there is no possibility of error due to uneven wetting of the glass as in an ordinary buret, it is allowable to have the opening of the tip sufficiently large to allow drainage in 10 or 15 seconds or even less. A coating of antiwetting agent on the outside of the tip will prevent inaccuracies due to wetting by the standard solution.

The buret should contain more than sufficient mercury to fill the calibrated barrel and at least an equal volume of *o*-dichlorobenzene. The standard solution should fill all the remaining space, and there should be no air bubbles anywhere in the buret.

The procedure for using the buret is quite simple. To fill it, stopcock *E* is closed, *D* is opened, and *A* is turned to the vacuum, causing the mercury to be drawn into the barrel *B*. Fine adjustment to the zero mark

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can be made by squeezing the tubing connecting *D* with the reservoir. Standard weight tubing which collapses when evacuated connects *A* and *B* and *G* to prevent over-shooting of the mercury. Next, stopcock *D* is closed, *A* is reversed, and the standard solution is dispensed through stopcock *E* as rapidly as desired.

Due to the compressibility of the liquids in tube *C* and the possibility of undiscovered air bubbles in the system, each observation of the mercury column should, for greatest accuracy, be made at equalized pressures in tube *C*. This is easily done by using the manometer shown at *G*. When a reading is to be taken, the system is evacuated until the height of the mercury column in *G* equals approximately the height of the column in *B*. Even without using the manometer the error is relatively small, and it may be practically eliminated by making rough corrections.

The usual corrections due to temperature are necessary. It is important that the time lapse between filling to zero and emptying and reading the buret should be short, particularly if the room temperature is changing. Otherwise a temperature correction must be made for the organic liquid as well as for the aqueous solution.

For standard solutions which are not attacked by mercury the protective layer of *o*-dichlorobenzene may be omitted.

Certain solutions such as standard iodine cannot be used in the buret as described since the organic solvent will extract the reagent. For use with iodine a substitute for tube *C* has been designed, as shown in Figure 2. A glass syringe tube and accurately fitting plunger *H* replace the *o*-dichlorobenzene. The plunger, lubricated with but a trace of light-weight and unreactive grease, should effectively prevent contact of the mercury and iodine or other reagent.

Figure 2. Reservoir Tube for Use with Iodine Solutions

H, glass syringe plunger inside accurately fitting barrel.

A buret barrel with a 30-ml. calibrated bulb on top of a 10-ml. graduated tube was used for acid iodometric titrations of potassium periodate and iodate mixtures. By choosing the proper concentration of sodium thiosulfate the first 30 ml. could be added very rapidly and the last few ml. more cautiously.

If it is desired to use the buret with solutions unstable in air, only the reservoir need be protected against the atmosphere.

DIFFERENTIATING BETWEEN PRIMARY, SECONDARY, AND TERTIARY ALCOHOLS

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A PRIMARY or secondary aliphatic alcohol dissolved in pure glacial acetic acid decolorizes a water solution of $KMnO_4$, while a tertiary alcohol fails to do so. A secondary alcohol will continue to react with $KMnO_4$ solution if a little concentrated sulfuric acid is added, while a primary alcohol does not. By means of these reactions one may distinguish between primary, secondary, and tertiary alcohols of the paraffin series. Further, no more than one drop of the alcohol is necessary to make the test, which fact should make it especially interesting in investigations where only small quantities of alcohol are available.

A convenient procedure is as follows: A 4-inch test tube is fitted with a one-hole rubber stopper carrying a glass rod which reaches to the bottom of the test tube. Glacial acetic acid (3 ml.) is introduced into the test tube, and then one drop of the pure unknown is added. A saturated, filtered solution of $KMnO_4$ in water is added, a drop at a time, to the contents of the tube, with stoppering and vigorous shaking between each addition.

If no decolorization of the $KMnO_4$ takes place, the alcohol is tertiary. If decolorization takes place (best ascertained from time to time by spotting the mixture by means of the glass rod onto filter paper), the addition of $KMnO_4$ is continued a drop at a time until the pink color of $KMnO_4$ persists. When decolorization

has ceased to take place a drop of concentrated H_2SO_4 is added and the addition of $KMnO_4$ with shaking is continued. If the pink color is not discharged under these conditions the alcohol is primary. If decolorization proceeds again after the addition of H_2SO_4, followed by a final permanent pink color, the alcohol is secondary.

It is advisable to run a blank test on the glacial acetic acid used, because some glacial acetic acid samples contain extraneous materials which react with $KMnO_4$ solution.

This method has been found reliable for all aliphatic alcohols through the amyl group. Whether it can be extended to other classes of alcohols has not been determined.

To a student in the laboratory it would seem that this different approach to the differentiation of the alcohols would be much more simple and direct than the Lucas test[1] currently in manuals.

[1] ADAMS, ROGER, AND J. R. JOHNSON, "Laboratory Experiments in Organic Chemistry," The Macmillan Co., New York, 1949, pp. 191–3.

CHEMISTRY AND ART WORK TOGETHER

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IT IS well known that natural lacquer, a product of the lacquer tree (*Plus vernicifera*) of the Orient,[1] has had an important and significant place in the arts of China and Japan. Its use dates back 2500 or more years and its lasting qualities are phenomenal.

In recent years, the lacquer of the Orient became an important consideration, both in England and America, in connection with a controversy existing among specialists in the ceramic arts of China. In the fifth pre-Christian century Chinese ceramicists produced a pottery characterized by very shiny, hard, black surfaces which came to be known as *Hui-hsien* ware. Following the Japanese occupation of North China, black statuettes and figurines, claimed to be genuine *Hui-hsien* specimens and presumably brought to Peiping by runners from *Hui-hsien*, made their appearance in the art markets of Peiping and Shanghai and found their way into the collections and museums of Japan, China, Europe, and America.

A widespread controversy highly significant to specialists in the Chinese ceramic arts arose with regard to the authenticity of these shiny, black-surfaced articles. Finally the difference of opinion came to be based upon whether the genuine *Hui-hsien* pottery received its unique shiny black surfacing by a burnishing or by a lacquering process. Following a meticulous study of the character of *Hui-hsien* ware and an intensive experimental study of competing specimens, the declaration was made by a modern ceramics specialist[2] that

Figure 1

[1] HARADA, JIRO, "A Glimpse of Japanese Ideals," Kokusai Bunka Shinkokai, Tokyo, Japan, 1937.

[2] HORAN, CLAUDE, *Bulletin, Honolulu Academy of Arts*, 13, No. 4 (1951).

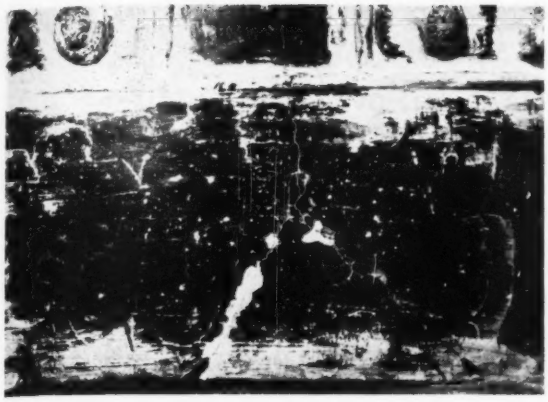

Figure 2

neither burnishing nor reduction alone, nor any of five familiar causes of the glossing of pottery surfaces, could have brought about the actual appearance of the authentic *Hui-hsien* objects. The utilization of various other criteria of a ceramics specialist[3] failed to provide a basis for distinguishing with certainty the marks of authenticity from those of fraud. It therefore became apparent that it was necessary to determine whether or not the surfaces of genuine *Hui-hsien* pottery were produced by a lacquering process.

The Honolulu Academy of Arts made available for laboratory investigation a precious 7 1/2-inch *Chan-kuo* (warring states) pottery bell, Figure 1, known to be a true *Hui-hsien* specimen.[4] The outside surface of the bell is sharply crackled, a condition associated by ceramicists with the ancient use of lacquer, Figure 2. Permission was granted for experimentation on the inside of the bell.

Preliminary tests with a variety of organic solvents on very small areas showed that the clean, hard, permanent surface could be *penetrated*, *softened*, and *reduced* to a dull claylike surface, gray in color. At the same time a black, carbonaceous powder was released.

Solvents were then applied to larger surface areas with the same results. Figure 3 shows a treated area and also gives evidence, from the streaked appearance, of the use of a brush in lacquer application. Amyl acetate in 17 separate, small portions, ethylene glycol monomethyl ether in 24 portions, and ethylene glycol monoethyl ether in 11 portions were applied consecutively, filtered separately, each partially evaporated, and finally combined on a watch glass for complete evaporation. A very thin, transparent, almost colorless, hard film with the appearance and character of lacquer remained on the watch-glass receiver. The photograph of the film is shown in Figure 4. Blanks were run on the pure solvents and residues were entirely absent.

Before the solvent treatment, it was impossible to transfer any black material to a cloth or to the hands even by vigorous and persistent abrasion. After the extensive extraction process, the surface of the bell was covered with a loose black powder resembling lamp black which was easily rubbed off by a cloth or by the fingers.

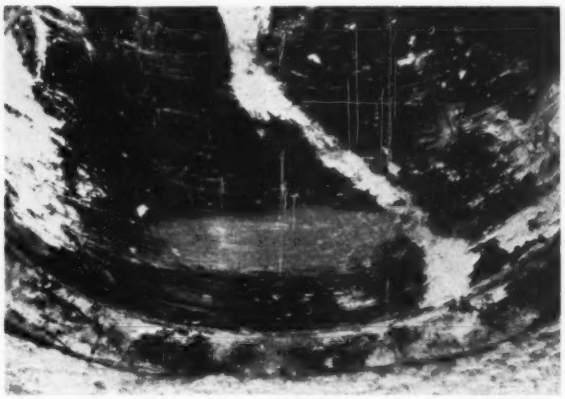

Figure 3

The conclusion was drawn that the black, glazed, hard, permanent surface on the *Chan-kuo* pottery bell had been produced by a lacquering process. The results were in agreement with the expert opinions and measured judgment of two specialists, the latter two co-authors of this paper.

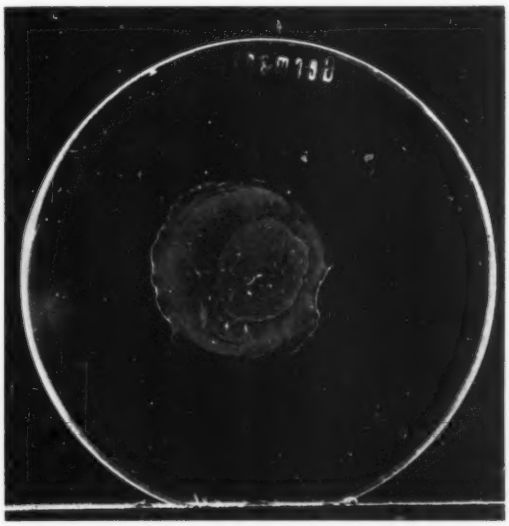

Figure 4

[3] Ecke, Gustav, *Artibus Asiae*, **15**, No. 4 (1953).

[4] Illustrations by courtesy of the Honolulu Academy of Arts, and *Artibus Asiae*, Ascona.

NATURALLY OCCURRING RADIOISOTOPES

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It is generally realized that such radioactive elements as technetium, promethium, and those with atomic numbers over 92 do not occur naturally on earth because the half-lives of their isotopes are so short that any which existed at the time of the formation of the planet have long since decayed. The radioactive elements, uranium and thorium, as well as a few radioactive isotopes of simpler elements are, however, found in nature because of their unusually long half-lives.

So far as the author knows, no quantitative treatment of this matter has as yet appeared in the literature, although it is fairly simple to calculate the degree to which any isotope has decayed during the lifetime of the earth, provided the isotope's half-life is known. Thus, the percentage of the original quantity of a given radioactive isotope still surviving today can be represented by the following equation:

$$S = 2^{-E/\tau_{1/2}} \times 100 \qquad (1)$$

where S is the percentage of the isotope surviving today, E is the age of Earth, and $\tau_{1/2}$ is the half-life.

If the age of the earth is set at 3.35×10^9 years,[1] then equation (1) becomes:

$$S = \text{antilog}\left(2 - \frac{1.0008 \times 10^9}{\tau^{1/2}}\right) \qquad (2)$$

Sullivan's chart of isotopes[2] lists ten long-lived radioactive isotopes upon which equation (2) may be used profitably. Using Sullivan's values for half-lives of all these isotopes except La^{138} (for which he gives none) and using the value given by Pringle, *et al.*,[3] in the case of that isotope, the accompanying table can be prepared. It is interesting to note that the one element that has altered its isotopic composition considerably over the geologic ages has been uranium. In the beginning, 5.5 per cent of the uranium atoms were the now famous U^{235}. Today, the corresponding figure is only 0.71 per cent.

How short may a half-life be to allow significant survival? We may answer this question by taking an extreme example. The mass of the earth is about 6.0×10^{27} g. If we were to imagine this entire mass to have been originally composed of neptunium's most long-lived isotope, Np^{237}, the number of neptunium atoms existing would have been 1.5×10^{49}. From equation (2) it can be calculated that if Np^{237} had a half-life of 20 million years, that colossal number of atoms would, nevertheless, have decayed in the over three billion years of the earth's existence to such an extent that today only one such atom would exist. Since Np^{237} has, in actual fact, a half-life of only 2.2 million years, it is not surprising that it does not occur naturally on the earth. Since the isotopes listed in the table (plus, perhaps, the one or two doubtful cases such as In^{115}, concerning whose radioactivity there is yet some question) are the only ones with half-lives greater than 20 million years, they are the only radioactive isotopes whose atoms may be said to have existed continuously since the formation of the earth.

Survival of Long-lived Radioactive Isotopes

Isotope	*Half-life, years*	*Per cent of isotope surviving today*
K^{40}	1.4×10^9	19.1
Rb^{87}	6.3×10^{10}	96.4
La^{138}	1.2×10^{11}	98.1
Nd^{150}	5×10^{10}	95.5
Sm^{152}	2×10^{11}	98.9
Lu^{176}	2.4×10^{10}	90.8
Re^{187}	4×10^{12}	99.92
Th^{232}	1.4×10^{10}	84.7
U^{235}	8.9×10^8	7.38
U^{238}	4.5×10^9	59.7

Isotopes of half-life lower than 20 million years are found on earth in what may be called "micro-quantities," their atoms having been formed in one of the three following ways long after the earth's origin:

(1) Through the decay of a long-lived precursor. Sullivan's chart lists 39 isotopes of the elements thallium, lead, bismuth, polonium, astatine, radon, francium, radium, actinium, thorium, protactinium, and uranium as "naturally occurring," due to their places in the radioactive decay chains of Th^{232}, U^{235}, and U^{238}. Their mass numbers vary from 206 to 234, and their half-lives vary from 230,000 years in the case of U^{234} to 2.6×10^{-7} seconds in the case of Po^{212}. The most famous of this group is the radium isotope, Ra^{226}, with a half-life of just over 1600 years.

(2) Through the natural transmutative processes continually occurring on earth. For instance, the carbon isotope, C^{14}, with a half-life of only 5700 years, nevertheless exists in measurable quantities because of its formation from N^{14} by cosmic ray bombardment.

(3) Through controlled nuclear reactions in the laboratory. The most famous case of this is the plutonium isotope, Pu^{239}, with a half-life of only 24,000 years, which now exists in quantities sufficient for the critical mass to have been exceeded many times.

[1] Holmes, A., *Nature*, **163**, 453 (1949).
[2] Sullivan, W. H., "Trilinear Chart of Nuclear Species," John Wiley & Sons, Inc., New York, 1949.
[3] Pringle, R. W., S. Standil, and K. I. Roulston, *Physiol. Rev.*, **78**, 303 (1950).

TEACHER TRAINING IN RADIOISOTOPE TECHNIQUES

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In the winter of 1951–52 Mr. Samuel Schenberg, Supervisor of Science in the New York City High Schools, approached Mr. Corbin Allardice of the Public Information Service, New York Operations Office, U. S. Atomic Energy Commission, on the possibility of developing an In-Service training course to instruct the science teachers of the city in the uses of radioactive isotopes for the teaching of biology, chemistry, and physics. As a result, a series of 14 lectures was prepared to give teachers a general background in nuclear science and to provide a series of specific elementary-level experiments for use in their classes. The lecture demonstrations were designed for two-hour periods, with a good deal of time left for direct questions on the theory and techniques involved.

After the initial presentation of this course to about 300 New York City science teachers in the spring of 1952, there have been many requests for a repetition in other cities. The course has been repeated in Baltimore under the auspices of Loyola Evening College, Graduate Division, in the fall of 1952. Also, in the fall of 1952 the course was given at Springfield, Massachusetts, under the auspices of the Science Department of the City School System. It has also been given at Glen Ridge, New Jersey, for science teachers in that area.

The following is a general description of the individual lectures and the speakers for the original course given in New York City.

(1) *Introduction to Isotopes*, by Dr. Paul C. Aebersold, Chief, Isotopes Division, U. S. Atomic Energy Commission, Oak Ridge. The lecture included basic information on isotopes with emphasis on manufacture, handling, storing, and transportation. Actual shipping containers and handling devices were shown.

(2) *Uses and Importance of Radioisotopes*, by Dr. V. Lawrence Parsegian, Director, Research Division, New York Operations Office, A. E. C. The lecture discussed the relative importance of radioisotopes in chemistry, physics, biology, agriculture, and industry. Slides depicting the various applications of radioisotopes were shown.

(3) *The Modern Concept of the Atom* by E. B. Merservey, Research Division, New York Operations Office, A. E. C. The present concept of the structure of the atom and its nucleus was discussed. The use of the cloud chamber in studying atomic particles was demonstrated and the construction of two simple student-models of the cloud chamber was explained.

(4) *Experiments with Atomic Particles*, by Evelyn Jetter, Electronics Engineer, Health and Safety Division, New York Operations Office, A. E. C. This lecture demonstration covered the use of the electroscope, experiments in the discrimination between beta and gamma radiation, beta and gamma absorption, and a demonstration of the inverse-square law.

(5) *Experiments with Atomic Particles* (continued), by Evelyn Jetter. A lecture demonstration covered the scattering of radiation, beta and gamma shielding, the decay of isotopes, and measurements of half-life.

(6) *The Operation, Use and Care of Geiger Counters*, by H. DiGiovanni, Electronics Engineer, Health and Safety Division, New York Operations Office, A. E. C. A detailed discussion and demonstration of the Geiger counter currently used in New York City High Schools. Two simple Geiger counters, suitable for student construction, were explained.

(7) *Fundamentals of Radioactivity*, preview of a motion picture film produced by the U. S. Signal Corps in cooperation with the A. E. C. Isotope Division.

(8) *General Radio Chemistry*, by John H. Harley, Chief, Analytical Branch, Health and Safety Division, New York Operations Office, A. E. C. This lecture covered the chemical behavior of isotopes and typical applications to chemical studies. Two experiments demonstrating the separation of uranium from its daughter elements were performed.

(9) *Analytical Applications of Radioisotopes*, by John H. Harley. This lecture discussed the application of radioisotopes to solubility measurements, the measurements of separation efficiency, the study of coprecipitation, and the study of absorption on glass. Radioactive iodine was used in an experiment to demonstrate the solubility of a precipitate and in another application to demonstrate tracer application of radioisotopes to solvent extraction.

(10) *Radioisotopes in Physical Chemistry*, by John H. Harley. The application of radioisotopes in the field of physical chemistry was discussed. The use of radioisotopes in studying reaction velocities and ion conductivities and in determining organic structures was explained. Experiments utilizing radioiodine to demonstrate diffusion in a solution and chemical equilibrium were performed.

(11) *Translocation of Elements in Plants*, by Dr. L. P. Miller, Research Chemist, Boyce Thompson Institute for Plant Research, Yonkers, and R. M. Weed, Assistant Plant Physiologist. A lecture demonstration

using radioactive phosphorous showed that minerals taken up by the roots move upward in plants and that materials absorbed by leaf tissues move downward in plants. The preparation of plant radioautographs was demonstrated.

(12) *The Absorption and Circulation of Foods*, Dr. Jacob Sachs, Department of Biology, Brookhaven National Laboratory. A lecture demonstration showed that foods are absorbed from the alimentary canal into the blood and carried to all parts of the body. Radioactive phosphorus was used in the experiment.

(13) *Selective Assimilation of Food by Various Body Tissues*, Dr. John F. Bonner, Assistant Professor of Biochemistry, Atomic Energy Project, School of Medicine and Dentistry, University of Rochester. A lecture demonstration showed that specific substances when absorbed may settle in specific places in the body. Radioactive phosphorus was used in the experiment.

(14) *The Concentration of Iodine in the Thyroid*, Dr. S. M. Seidlin, Chief, Medical Physics Research Laboratory, Montefiore Hospital, New York City. The concentration of iodine by the thyroid was demonstrated using rats. The application of radioiodine to diagnosis and therapy was discussed.

The lectures were arranged in groups, the first of which comprised three lectures covering background material on recent developments in physics which are so important to an understandig of radioactivity. The next three lectures included basic experiments on the properties of radiation and radiation measurements. The film, "Fundamentals of Radioactivity,"[1] served as an excellent summary and review of the first six lectures and was better understood because of the basic preparation which the teachers had received. The next set of three lectures covered chemical applications of radioisotopes, while the last four lectures were on biological and medical aspects of radioisotope utilization.

The modification of such a course to bear more directly on chemistry would only allow the dropping of the last four lectures on the biological aspects. In the development material, the aspects of radioactivity and of radioisotopes, which might appear to be more directly concerned with physics, are very necessary in developing the concepts later used in the application of isotopes to the teaching of chemistry.

It is possible to cover only specific prerequisites for understanding the properties of isotopes that appear in chemical demonstrations if a specialization in chemistry is desired. As an introduction to the uses of isotopes in chemistry teaching, this idea was carried out by the author at the 1952 Summer Conference of the New England Association of Chemistry Teachers in Burlington, Vermont. A single day split into two 3-hour periods was used to cover first, the fundamental properties of radiation and radiation measurement and second, demonstrations of the use of isotopes in analytical and physical chemistry. While such a concentration of material is not the ideal method of presentation, the brief survey served to stimulate interest of the teachers attending the conference in the use of radioisotopes. This has been true, as judged by the amount of subsequent correspondence on the subject. The publication of selected experiments in the *Newsletter* of the NEACT will help to maintain the interest of the group in the future.

A more detailed outline of the three original chemistry lectures is given below. This material, somewhat condensed, was also given at the 1952 NEACT Summer Conference.

General Radiochemistry

I. Usefulness of Isotopes in Chemistry
   - A. Radioactivity easily detected and measured.
   - B. Chemical properties of active and inactive isotopes are identical.
   - C. Activity may be used to follow the path of a particular element or the course of a reaction (tracer applications).

II. Desirable Characteristics of Isotopes for Tracer Work
   - A. Available at low cost. The sources of isotopes in order of increasing cost are fission products, pile irradiation, and accelerators. For pile and accelerator products, a shorter half-life isotope is less expensive.
   - B. Suitable activity. Gamma activity easiest to measure (not absorbed by samples).
   - C. Suitable half-life. Ideal half-life of the order of a few days. This gives sufficient working time and yet the isotope decays away completely with a short storage period.
   - D. Suitable energy. The radiation energy must be high enough to be readily measurable.

III. The Natural Radioactive Series
   - A. Long-lived isotope as parent, decaying in several steps to stable lead isotope.
   - B. Four series known, typified by the uranium series.
   - C. Useful as sources of inexpensive isotopes.

IV. The Separation of Uranium from its Daughters

Two methods of separating uranium (U^{238} plus U^{235}) from its daughter products (Th^{234} and Pa^{234}) are precipitation and solvent extraction. The first method is demonstrated by adding a large excess of Na_2CO_3 to a solution of uranyl nitrate. Addition of a small amount of ferric ion serves to coprecipitate (carry) the daughter products. The second method is demonstrated by saturating a solution of uranyl nitrate with NH_4NO_3. The uranium may then be extracted with ethyl acetate, leaving the daughters in the aqueous portion. In both cases the beta activity of the daughters may be used to measure separation efficiency.

Analytical Radiochemistry

I. Activity Units
   - A. The curie.
   - B. The rutherford.

II. Gamma Activity Calculations for Tracer Work

Assumptions
1. The initial counting rate wanted.
2. The efficiency of the counter for gamma rays.
3. The geometry of the counting arrangement.

From these assumptions the number of d./m. and hence the number of microcuries required for an experiment may be calculated.

It is of interest to calculate the number of radioactive atoms and the actual weight of the isotope used.

III. Tracer Applications
   - A. Determination of solubility.
   - B. Determination of coprecipitation.
   - C. Determination of separation efficiency.
   - D. Determination of absorption on glass.

[1] Available from Army Signal Corps film libraries on loan.

IV. Demonstration of Solubility of Lead Iodide

One-quarter gram of KI spiked with 5 microcuries of I^{131} is precipitated with an excess of lead ion. The precipitate is filtered, washed, and suspended in 100 ml. of water. After filtration the activity of the filtrate is measured and the solubility of lead iodide calculated.

Physical Radiochemistry

I. Tracers are powerful tools in the study of equilibria, as particular species of an element may be tagged. In the reaction,

$$S + SO_3^{--} \rightarrow S_2O_3^{--}$$

either the free or sulfite sulfur may be tagged. The dynamic aspects of an equilibrium such as,

$$I + e^- \rightleftharpoons I^-$$

may be approached more readily with the use of isotopes.

II. Diffusion

The processes of diffusion and self-diffusion have been studied by tracer techniques. The most interesting application is self-diffusion, which cannot be measured otherwise. An example would be the plating of Cu^{64} on one face of a thin sheet of copper. The copper is held at various temperatures for stated periods. The increase in activity with time, as measured at the back of the sheet, is a measure of the diffusion of Cu^{64} into the inactive copper.

III. Sorption of Ions by Glass and Other Materials

The high sensitivity of tracer methods allows the study of very thin films of ions or atoms deposited on surfaces. This sorption also can affect other experiments. For example, tests with Pb^{212} indicate the following loss of ions from solution when kept in glass bottles.

Solution	% Loss
Neutral	15
0.01 *N* acid	0
0.0001 *N* acid	21
0.01 *N* NaOH	70

IV. Demonstration of Iodine-Iodide Equilibrium

Four equal portions of a KI solution (about 0.01 g. each) are placed in separatory funnels and two portions spiked with about 5 microcuries of I^{131}. One spiked and one inactive solution are oxidized with H_2O_2 and the iodine extracted with CCl_4. The spiked iodine is drawn off into the inactive iodide and vice versa. After a brief shaking the layers are separated and gamma activity of the four portions are measured. The equal distribution of activity is a demonstration of the dynamic aspects of equilibrium.

In order to aid the science teachers of New York City a laboratory manual was prepared during the summer of 1952. Six teachers from the school system, working at the laboratories of the New York Operations Office, U. S. Atomic Energy Commission repeated the demonstrations shown during the course and developed new experiments which could be used in high schools in the three science fields. This manual is available in mimeographed draft form (without charts or illustrations) from the Educational Services Branch, Division of Information Services, U. S. Atomic Energy Commission, Washington, D. C. It is contemplated that it will be published in 1953 through the U. S. Government Printing Office.

The manual, entitled "Laboratory Experiments with Radioisotopes for High School Science Demonstrations," describes 21 experiments which can be carried out at the high-school level using a simple count-rate meter as the major apparatus and small quantities of the more common radioisotopes for tracers. The experiments are listed below.

(1) Operating the count-rate meter.
(2) Determining counter efficiency.
(3) Preparing a continuous cloud chamber.
(4) Half-life measurement.
(5) Absorption of beta radiation.
(6) Absorption of gamma radiation.
(7) Magnetic deflection of beta particles.
(8) Inverse-square law.
(9) The scattering of beta radiation.
(10) Thickness measurement.
(11) Nuclear properties independent of chemical reaction.
(12) Diffusion using radioactive isotopes as tracers.
(13) Electroplating of radioactive cobalt.
(14) Chemical properties of isotopes of the same element.
(15) Separation of uranium from its daughter products.
(16) Translocation of radioactive phosphorus (P^{32}) in tomato plants via the roots.
(17) Translocation of radioactive phosphorus (P^{32}) upward and downward in the tomato plant via the stem.
(18) Removal by goldfish of radioactive phosphorus (P^{32}) from water.
(19) Localization of radioactive iodine (KI^{131}) in the white rat.
(20) Absorption of radioactive phosphorus by bacteria and molds.
(21) Preparation of radioautographs.

There are no doubt many additional experiments which can be demonstrated more graphically by the use of radioactive isotopes than by other methods, but the range of material covered is sufficient for most science courses at the elementary level.

The most obvious advantages in the use of radioisotopes in science teaching lie in the possibility of evolving more dramatic demonstrations and in generating the feeling that the course presented is progressing with the times. Naturally, there has been considerable publicity on "education in the atomic age" but these spectacular qualities of radioisotope utilization are less important than their ability to help us teach better.

The response of the teachers has been very interesting. Some have been intrigued by the wonder of it all, some have prepared carefully thought-out methods of using isotopes, and a very large number have been grateful for the opportunity to obtain an introduction to this subject purely as a matter of their own personal development, even though they feel that they cannot utilize the techniques at the present time.

There has not been sufficient time to gage the response of the high-school students themselves, as the methods are being used only in scattered schools this year in the New York system. The student groups that were shown experimental demonstrations were extremely interested in the timeliness of isotope studies, but whether the demonstrations provided more than a sensation could not be measured.

The introduction of isotope techniques into teaching can be done ideally when there is a minimum of fanfare. The fear of radioactivity has probably been more highly impressed upon the general public than any other aspect. If isotope utilization is taken as a matter of course, then there should be no problem in

public reaction. The amounts of isotopes handled by the teachers are so small that no possible damage can be caused by any accident or by any misuse of the material.[2] The supply of such isotopes is not a difficult problem, as amounts up to ten microcuries are available commercially from suppliers of radiation-measuring equipment or from hospitals using radioisotopes in diagnosis or therapy. The recommended isotopes, P^{32}, I^{131}, Na^{24}, Co^{60}, or the naturally occurring isotopes and daughters derived from uranium salts, can be handled safely. Other isotopes can only be obtained from the U. S. Atomic Energy Commission upon proof that the facilities and knowledge of the buyer are sufficient to insure safe operation. There is no hazard involved in the experiments described. Such experiments for student use, rather than for demonstration, would be a matter of policy but would certainly be no more hazardous than the ordinary chemical experiments carried out at the high-school level.

Anyone interested in conducting a similar course of instruction for teachers can obtain lecture outlines and other material from the office of Public Information Service, New York Operations Office, U. S. Atomic Energy Commission, or from Educational Services Branch, Division of Information Service, U. S. Atomic Energy Commission, Washington, D. C., as a basis for planning. Almost any area in the country now has specialists who can present various portions of the course—college or university staff members working with isotopes, industrial isotope users, and members of hospital staffs where isotopes are used in diagnosis or therapy. The major requirement is that the speaker should be able to present the material at the required level. The teachers are not trying to become atomic scientists but do want to obtain a working knowledge of the field and an understanding of the fundamentals which can be passed on to their students.

[2] An informative and accurate circular on this subject has been issued by Mr. Schenberg for the New York City Board of Education.

PRASEODYMIUM TETRAFLUORIDE

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Among the elements of the rare earth group, only cerium is known to form quadrivalent salts. These are the familiar ceric salts. It might be expected that praseodymium, the element of next higher atomic number, would also form comparable compounds. However, the dioxide PrO_2 and one or two of its derivatives such as Pr_6O_{11} and Na_2PrO_3 are the only reported compounds which contain praseodymium in the quadrivalent state. A report (*1*) claiming that praseodymium (IV) has been prepared as a complex with 8-quinolinol-5-sulfonic acid has not been substantiated. From a consideration of the electronic configuration of praseodymium, one would even predict the existence of the pentavalent oxidation state. Evidence for this has been presented by Prandtl and Rieder (*2*) who concluded from their investigations that the oxide, Pr_2O_5, was a component of the mixed oxide Pr_6O_{11}. However, Marsh (*3*) in repeating their work found no evidence for Pr_2O_5 but only for PrO_2.

[1] Present address: National Bureau of Standards, Washington, D. C.

Since PrO_2 contains praseodymium in the quadrivalent state, a number of investigators have used it as a starting material in an effort to prepare quadrivalent salts of praseodymium (*4, 5, 6, 7, 8, 9*). In no instance was evidence found for the formation of quadrivalent praseodymium.

If oxygen is capable of producing the quadrivalent oxidation state, it would be expected that fluorine could also produce that state, *i. e.*, as praseodymium tetrafluoride. The cerium analogue is easily prepared and quite stable (*10*). Klemm and Henkel (*11*) treated praseodymium trichloride with fluorine and obtained a mixture of the trichloride and trifluoride but no evidence of the tetrafluoride. Recent attempts to fluorinate the oxides (*12*) and the trifluoride (*13*) of praseodymium produced no evidence for quadrivalent praseodymium.

In spite of the experimental failures to prepare praseodymium tetrafluoride, there is strong evidence for its possible formation. This is to be found by calculating the equilibrium constants for some of the reactions by which praseodymium tetrafluoride may be prepared.

The standard heats of formation, $\Delta H_f°$, for the rare earth fluorides are not known. Therefore, estimates of these values are made which leave little doubt as to the validity of the conclusions derived from the calculations using these values. The heats of formation of praseodymium trifluoride and praseodymium tetrafluoride are estimated first. The heats of formation used in making these estimates are from the recent compilation by the National Bureau of Standards (*14*). The table lists $\Delta H_f°$ at 298.16°K. for some of the trihalides of rare earth elements together with those for uranium and neptunium. The third column contains the difference between the heat of formation of the trichloride and the triiodide.

Element	$-\Delta H_f°$ (kg.-cal./mol) XCl_3	XI_3	*Difference*
Cerium	260	164	96
Praseodymium	258	162	96
Neodymium	254	159	95
Samarium	250	153	97
Lanthanum	264	167	97
Uranium	213	115	98
Neptunium	216	120	96

From an examination of the data in column three of the table, it seems reasonable to assume that the values $\Delta H_f°$ of praseodymium trifluoride and praseodymium tetrafluoride should bear the same relationship to that for praseodymium trichloride that the corresponding uranium and neptunium tri- and tetrafluorides do to uranium trichloride and neptunium trichloride. The heats of formation of uranium trifluoride and neptunium trifluoride are −357 kg.-cal./mol and −360 kg.-cal./mol, respectively. The difference between the values for the trichloride and the trifluoride is in each case 144 kg.-cal./mol. Hence, the heat of formation of praseodymium trifluoride is taken as

$$\Delta H_f° = (-258) - (144) = -402 \pm 10 \text{ kg.-cal./mol}^2$$

The heats of formation of uranium tetrafluoride and neptunium tetrafluoride are −443 kg.-cal./mol and −428 kg.-cal./mol, respectively. The difference between these figures and those for the corresponding trichlorides are 230 and 212 kg.-cal./mol for the uranium and neptunium salts, respectively. The value estimated for the difference between the heats of formation of the praseodymium trichloride and the tetrafluoride is 220 kg.-cal./mol. The heat of formation of praseodymium tetrafluoride is then taken as:

$$\Delta H_f° = (-258) - (220) = -478 \pm 20 \text{ kg.-cal./mol}$$

The entropies of praseodymium, praseodymium trifluoride, praseodymium tetrafluoride, and fluorine are still required. The entropy of praseodymium is taken as 13.7 e.u. from the recent work of Latimer (*15*), that of fluorine as 48.6 e.u. from the NBS compilation (*14*). By recourse to the work of Latimer and by noting trends in the periodic table the value 23 ± 3 e.u. is taken for praseodymium trifluoride and 32 ± 3 e.u. for praseodymium tetrafluoride.

Using these values the increment in the Gibbs free energy may be calculated for reaction (1):

$$\text{Pr (c)} + 2\text{F}_2\text{ (g)} = \text{PrF}_4\text{ (c)} \qquad (1)$$

$$\begin{aligned}\Delta H°_f &= -478 \pm 20 \text{ kg.-cal./mol}\\ \Delta S° &= -79 \pm 4 \text{ e.u.}\\ \Delta F° &= \Delta H° - T\Delta S°\\ \Delta F° &= -454 \pm 21 \text{ kg.-cal./mol}\end{aligned}$$

The equilibrium constant for reaction (1) may now be obtained from the familiar expression $\Delta F° = -RT \ln K$.

$$\begin{aligned}\log_{10} K &= -\Delta F°/4.576T\\ &= 336 \pm 15\end{aligned}$$

From this it can be seen that the equilibrium in reaction (1) is far in favor of the formation of praseodymium tetrafluoride. By making rough estimates of the necessary quantities it can be shown that even at temperatures up to about 700°C. the equilibrium should be substantially in favor of the praseodymium tetrafluoride. The melting point of praseodymium tetrafluoride is estimated to be 1000 ± 50°K. It may be concluded that praseodymium tetrafluoride is quite stable with respect to the elements.

In the same manner, the equilibrium constant for reaction (2) may be determined:

$$\text{PrF}_3\text{ (c)} + {}^1/_2\text{F}_2\text{ (g)} = \text{PrF}_4\text{ (c)} \qquad (2)$$

$$\begin{aligned}\Delta H° &= -478 - (-402) = -76 \pm 30 \text{ kg.-cal./mol}\\ \Delta S° &= -15 \pm 32 \text{ e.u.}\\ \Delta F° &= \Delta H° - T\Delta S°\\ &= -72 \pm 24 \text{ kg.-cal./mol}\\ \log_{10} K &= -\Delta F°/4.575T\\ &= 54 \pm 24\end{aligned}$$

The value here also indicates that praseodymium tetrafluoride, once prepared, would be stable. On the basis of the above calculations, which are felt to be valid within the limits indicated, it would appear that further experimental work in developing a method for the preparation of praseodymium tetrafluoride is warranted.

[2] The assigned uncertainties are the authors' estimates of the maximum uncertainty involved in the stated values.

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BASIC RESEARCH IN TOBACCO CHEMISTRY

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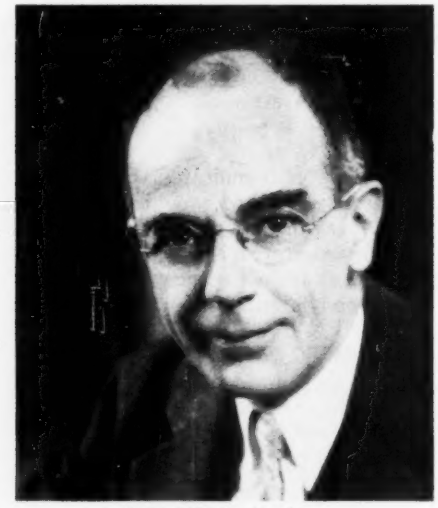
THIS year marks the 60th anniversaries of two scientists, one a biochemist and the other a physical chemist, whose researches have set a model for the investigation of a major agricultural crop and have provided a principal stimulus for the advent of organized research in the industry. The coincidence by which a single uncultivated field came to a high state of fruition in the hands of two individuals, whose primary research interests lay elsewhere, forms the basis for so impressive a chapter in contemporary science that special notice is both instructive and timely. A few of the outstanding contributions of both men are summarized here in the logical order in which they apply to the growing and processing of cigar-type tobaccos.

Dr. Hubert Bradford Vickery, head biochemist of the Conneticut Agricultural Experiment Station, came to the United States from Canada. He matured,



Hubert Bradford Vickery

scientifically speaking, under the influence of the rich tradition of research on the vegetable proteins conducted by Samuel Johnson and Thomas Osborne at New Haven. The preparation and characterization of proteins and amino acids has remained Dr. Vickery's primary interest, but in the early 1930's he undertook a long-term investigation of Connecticut's most valuable crop, shade-grown cigar-wrapper tobacco. In collaboration with George Pucher and with the skilled technical assistance of C. S. Leavenworth and A. J. Wakeman he devised a series of quantitative analytical methods for the measurement of principal plant constituents (*e. g.*, the carbohydrates, organic acids, proteins, amides, ammonia, nitrate, etc.), which methods still remain the generally accepted standards for plant chemistry.

By 1935 the development of these methods had progressed to the point where a full-scale investigation could be undertaken of the chemical changes that occur during the growth of the tobacco plant. This study not only constitutes one of the very few reliable accounts of the changes in major metabolites and inert structural materials through the growth and developmental cycle of a higher plant but also provides a general picture of the chemical state of the green tobacco leaf before it is cut and transported to the curing barns in the first stage of its commercial processing.

Simultaneously, there was begun a study of the chemical changes that take place during the curing of the harvested leaf. Curing is, superficially, a gradual drying process in the course of which leaf color slowly changes from green through light green and yellow to lighter or darker shades of brown, as first the chlorophylls and finally the carotenoids of the plastids are destroyed and brown pigments of unknown identity take their place. By applying their newly perfected methods of analysis to the curing of leaves, Dr. Vickery and his colleagues were able to establish that curing is essentially a process of rapid starvation of leaf cells succeeded in the later stages by autolysis. That is, for a few days following initial detachment from the plant, the normal foodstuffs and food reserves of the cells are digested and in part oxidized via the usual pathways of enzymically catalyzed respiration. As dehydration progresses, however, these relatively normal changes are succeeded by a more deep-seated attack on the protoplasm of the cell and upon the cell structures such as the chloroplasts, with the result that the leaf tissues descend irreversibly upon the pathways leading to death by starvation and desiccation. One of the most important of these chemical changes from the standpoint of making fine cigar tobacco is the destruction of the leaf proteins. Dr. Vickery was able to show that proteins are digested to amino acids in the curing leaf and that the amino acids are then largely converted to asparagine and to carbon compounds which presumably can enter the oxidative pathways of respiration. In later stages, carbon skeletons for the synthesis of asparagine, arising from this presumed oxidative deamination of free amino acids, apparently occur in short supply, and the ammonia so liberated begins to accumulate as such.

A highly useful innovation of these studies was the slowing of dehydration and consequent protraction of chemical changes by the use of water cultures of excised leaves. When the possibilities of this approach for

the study of curing had been exploited, Dr. Vickery turned it to good use in an extensive investigation of the pathways of organic acid metabolism in the green tobacco leaf. It had already been found that malic acid disappears and citric acid increases in the cultured tobacco leaf approximately in the ratio of two mols of the former to one of the latter. The obvious implication that respiration in the tobacco leaf involves a cyclical process, perhaps similar to the Krebs citric acid cycle, was examined by the simple technique of supplying different acids of the cycle to excised tobacco leaves in solution culture and following analytically the changes in the organic acid constituents. Thus, the earlier findings that malic acid can be converted into citric acid were readily confirmed. When citric acid was supplied instead of malic, the amounts of both acids increased, and feeding isocitric acid also yielded an increase in citric acid. Acetic acid was metabolized in substantial amount without altering the steady state concentrations of malic and citric acids. Succinic and fumaric acids also yielded malic and citric when supplied through these solution cultures. Oxalic and tartaric acids were taken up by the leaves but remained essentially unchanged. These results are consistent with the view that a citric acid, or tricarboxylic acid, cycle is operative in the tobacco leaf and that it may provide a general pathway for the oxidation of the carbon skeletons of carbohydrates, fats, and amino acids during the curing process.

The effects of nitrate and ammonium fertilization upon the composition of whole tobacco plants were also studied with the result that some of the adverse affects of ammonium fertilizers upon burn and smoking quality could be explained in terms of the relative contents of carbohydrates and organic acids. A higher proportion of ammonium nitrogen in the nutrition of the plant leads to progressively lower concentrations of organic acids and of carbohydrates even though the growth and dry weight yield of the plant may be unimpaired. Low contents of organic acids and of carbohydrates in the green cigar leaf prior to curing are thought to be incompatible with the best development of smoking quality during the processing of the leaf.

The more recent accomplishments of the New Haven laboratory under Dr. Vickery's guidance have centered about the next logical step in the quantitative analysis of chemical change in natural materials, namely the development of considerably more sophisticated methods of leaf sampling in order to reduce error variance in the final data to a level commensurate with the accuracy and precision of the chemical methods that they employ. The improvements made by the introduction of these improved sampling procedures include among other things an elegant confirmation of the sequence of events that occurs during the breakdown of protein and the production of asparagine and ammonia—an accomplishment that once again demonstrates the essential soundness of the analytical approach to problems of chemical change.

Dr. Vickery is well known to chemists for his outstanding services in the field of chemical nomenclature and in the guidance of editorial policy. He holds the Stephen Hales Award of the American Society of Plant Physiologists and has been recognized for his contributions to the program of research on blood plasma proteins during the last conflict.

Dr. Walter G. Frankenburg, director of research for the General Cigar Company, had already acquired an outstanding reputation as a physical chemist and an authority on catalysis before entering the tobacco field.

Walter G. Frankenburg

In Germany, he had written original articles and a book on catalysis and had developed a successful and novel method for color photography. Upon coming to the United States with his family prior to the outbreak of the European war, he took over the newly created research laboratory of the General Cigar Company in Lancaster, Pennsylvania; and began a series of brilliant researches on the chemical nature of the changes that occur during the fermentation of Pennsylvania cigar filler tobacco.

This type of tobacco, after curing, must be processed by a series of consecutive heats or "sweats" before its smoking qualities become fully developed. The nature of this sweat was not known, and its practical control under factory conditions had become a highly skilled and intuitive art. Nevertheless, there was encountered great variability between different crops or even different lots of the same crop with respect to the ease with which the sweat occurred. Dr. Frankenburg's first efforts were directed toward the analysis of this problem. Numerous experimental "sweats" under the controlled conditions of closed containers and the like indicated that the sweat is primarily a catalyzed

oxidation of certain tissue constituents left from the curing stage and that the reactants and the catalysts concerned are quite different in certain respects from those involved in the earlier stages of curing.

Extensive examinations of the chemical changes that occur during this fermentation showed that further destruction of carbohydrates, organic acids, and amino acids could be demonstrated, but also new classes of compounds were drawn into the maelstrom. The pectins and hemicelluloses began to decrease in amount, and the polyphenols also became deeply involved. An extremely puzzling phenomenon was the sudden upswing in amount of hot water and alcohol-insoluble nitrogen which is usually ascribed to protein nitrogen. For various reasons, Dr. Frankenburg regards this increased insoluble fraction as very likely arising from condensation reactions between free amino acids and oxidation products of the polyphenols. Indeed, he has discussed at length the possibility that in addition to themselves undergoing oxidation the polyphenols may actually catalyze the oxygen uptake of the fermenting leaf after the condensation with amino acids. If this hypothesis should be substantiated, it would undoubtedly possess great significance for the study of the control of color and aroma in tobacco of this type.

An apparent example of catalytic inhibition of considerable importance was also discovered by Dr. Frankenburg. Thus, the relative ease with which various lots of tobacco undergo the sweat was found to show a remarkable correlation with the nicotine content of the leaf prior to processing. The higher the alkaloid content of the leaf at the outset the greater the sweat resistance of the leaf. Still other correlations were established. The greater the extent of nicotine breakdown during the sweat the faster the sweat occurs and the shorter the time required for the processing. Finally, the lower the final alkaloid content of the fermented leaf, the higher will be its quality for smoking. Inconsistencies in the timing of oxidation of the polyphenols and the breakdown of nicotine make it seem unlikely that alkaloid disappearance is a simple concomitant of general oxidative reactions, but rather that such disappearance is desirable not only from the standpoint of reducing the nicotine content of the manufactured tobacco but also from the viewpoint of removing inhibitors of the final steps in the catalytic transformations of the sweat.

The obvious demand for a study of the breakdown products of nicotine during the successful fermentation was met by Dr. Frankenburg and his staff in a classical piece of research. A system of selective solvents was found by means of which the products of nicotine breakdown could be identified and evaluated as follows: 20 parts oxynicotine, 3 parts a mixture of 2,3′-dipyridyl and methyl-3-pyridyl ketone, 15 parts nicotinic acid, 30 parts water-insoluble pyridine derivative, 7 parts unidentified chloroform-soluble oxidation products, 18 parts unchanged nicotine and 7 parts unrecoverable as pyridine nitrogen. It is evident that the breakdown of nicotine in the fermenting tobacco leaf shares some features in common with the microbial decomposition of this alkaloid. It may be mentioned also that the fractionation of the nicotine breakdown products was greatly facilitated by the use of modern methods of ultraviolet spectrophotometry as adjuncts to the classical procedures of isolation, purification, derivative making, and elemental analysis.

More recent work of this laboratory has begun to emphasize the chemical nature of the presumed complexes between amino acids and oxidized polyphenols, the amino acid compositional changes of tobacco leaf proteins during fermentation, and the minor alkaloids of green tobacco.

Dr. Frankenburg is the holder of several patents on the use of catalysts for the production of hydrocarbons and the production of superior cigar wrapper from powdered tobacco leaf. He is active in the field of petroleum research as a consultant on catalysis and is co-editor of a review journal dealing with this field.

The infant field of tobacco chemistry will do well if in each succeeding generation it can boast of the services of two such giants as these.

MICHIGAN COLLEGE CHEMISTRY TEACHERS ASSOCIATION

THE following officers for the Association were elected on April 25 at the semiannual meeting in East Lansing:

President	Dr. J. A. Sellers Michigan State Normal College
Vice-president	Dr. George F. Brewer Marygrove College
Secretary-Treasurer	Dr. Lillian Meyer Western Michigan College of Education

ARE YOUR RESEARCH RECORDS SUFFICIENT?

JOHN H. WILLS
Philadelphia Quartz Company, Philadelphia, Pennsylvania

EACH research worker deserves the satisfaction that comes with the recognition that he is an inventor and has had a leading part in some field of human need. To a few will come a rude disenchantment, for a certain proportion will be called on to prove their right against a contemporary claimant. In case of doubt, the true, *i. e.*, the first or prior inventor of two or more contemporary applicants, as far as the law is concerned, is determined by an "interference" contest tried by the Patent Office. This is a full-fledged legal engagement with the taking of testimony, cross examination of witnesses, and hearings, etc. It requires all the skill of a good patent attorney, but depends on the adequacy of the records and witnesses which can be produced. Appeal may be taken to the Circuit Court of Patent Appeals or to the District Court.

Then comes the wish for more exact statements, clearer and more complete records. It seems then that there are never enough records and what there are, are not perfect. A number of good statements on the routine preparation of research records are available and most laboratories have circulated careful instructions. No doubt, research records in general now are in far better form than they were ten years ago.[1]

Unfortunately, no matter how carefully laboratory records are prepared, they are not sufficient in and of themselves to prove prior inventorship nor indeed is the inventor's own testimony sufficient no matter how convincingly stated. In priority contests technical rules of evidence are applied which demand proof of every small detail with nothing left to conjecture. Circumstantial evidence is practically disregarded and the junior party in the interference (*i. e.*, the last one to file his patent application) seems to have the burden of proving his priority of actual invention beyond a reasonable doubt although the courts still state that proof merely by preponderance of the evidence is sufficient. The difference in the kind of proof required will be obvious if thought is given to the ordinary meaning of the words in these two standards. It has been said to be more difficult to prove the actual reduction of an invention to practice than to convict a murderer. The primary objective of this paper is to make the necessity for something more than accurate research reports a vivid part of the inventor's experience by his vicarious participation in some actual cases tried before the patent tribunals.

When we go from a laboratory into a court of law, we are in an unfamiliar world. It is not that the legal mind does not believe our records and words, but it holds that, on the record, some men have uncertain or inaccurate memories and others have told lies and falsified records; therefore, testimony by interested parties, *i. e.*, defendant or accuser, is self-serving (biased or selfish) unless supported by a disinterested witness at the crucial points. Furthermore, the witness must be on hand for oral testimony in order that he may be cross-examined and the reliability of his statements be clarified and judged.

Time and again the judges have declared that their decision in no wise should be taken as a reflection on the honesty of men or their records; the judges are impelled by lack of corroboration on which they are permitted to rely to decide in favor of the inventor who files first. They have not been unaware of the feeling of frustration among chemists and inventors when their records have been found inadequate to sustain their dates. Judges have often tried to smooth these ruffled emotions by such explanations as the following:[2]

> Regardless of the high character of the appellants and the persuasiveness of their testimony, we are bound by the well-established rule of patent law that independent corroboration of the testimony of inventors is essential to establish actual reduction to practice of an invention, and that reports, official or otherwise, which are self-serving statements, cannot be considered as corroborative evidence of such reduction to practice. . . . It is unfortunate that many inventors are not aware of this rule.

A research worker comes into contact with this legal view most often in the Patent Office by way of interference action to determine the true inventor before the patent issues; less often, after the patent issues, in open court in an infringement suit where anticipation is in question. The critical problem in an interference is usually the proof of actual reduction to practice as of a given date as against the date of a "constructive reduction to practice," which means the filing date of a patent application. This is so difficult that, at least in chemical cases, the senior party (he who first files his application) often relies on his filing date without attempting to prove an earlier date from his laboratory records.

There is a tendency to feel that in an interference action in a chemical case the earlier date of an actual reduction to practice, *i. e.*, in the laboratory or industry, cannot be upheld against the date of a constructive reduction to practice prior to one's own filing date. Although there is a good bit of basis for this belief, there have been published and unpublished cases in

[1] TRIMBLE, F., J. CHEM. EDUC., **29**, 252 (1952); *ibid.*, **25**, 97–101 (1948); TUSKA, C. D., "Patent Notes for Engineers," RCA Review, Radio Corporation of America, RCA Laboratories Division, Princeton, N. J., **1947**; KOPP, P., *J. Patent Office Soc.*, **33**, 502 (1951).

[2] CRANE AND STOUT *vs.* CARLSON 540 O.G. 707 (1942).

which the junior party was successful in maintaining his actual reduction to practice. Where witnesses are able to state definitely that they have seen each step of the process, understood it, ascertained the identity of the product where the product was involved in the counts or claims, and have substantiated utility, reduction to practice may be upheld.

In the recent case of Scharmann *vs.* Kassel the testimony of some of the witnesses was accepted.[3] Dated contemporary documentary exhibits indicated the apparatus and the manner of the process. While these documents in themselves were not as complete, positive, and certain in their statements as one could wish and did not establish the precise date, they supplemented and corroborated the oral testimony of the witnesses. The court stated: "Appellee's proof of conception is to be found more readily in the testimony of corroborating witnesses rather than in his own." The forthright testimony which convinced this judge is found in the example of one witness who said, "I distinctly recall that Dr. Kassel on May 6, 1938, disclosed to me sketches of the design of the apparatus I had previously described." Although the credibility of the witnesses was severely attacked by the appellant's attorneys, the court said, "testimony of both those witnesses when considered in connection with the documentary exhibits has not been shaken or weakened but, on the contrary, stands as positive and forthright corroboration. . . ."

The case is of interest in other ways. It emphasizes the need for keeping complete records, as an early document was lost which would have substantiated the case for the appellant. The court took a very strict view in interpreting diligence both on the part of the attorney and the inventor.

For most inventions, filing of the patent application (constructive reduction) turns out to be sufficient to insure priority. The less important patent interferences which do develop are settled between the inventors or their attorneys, but on the basis of evidence which could be used in court. More important ones, those which have the most serious consequences to an inventor and his backers, are examined in detail by judges.

What precautions can be taken to be sure that reduction of the invention to practice before the application was filed can be proved in case of a challenge?

In one case it was held that laboratory tests to show actual reduction to practice may be judged by two criteria:[4]

> First, do the tests employed show that the product will serve the purpose for which it is designed, and show this so conclusively that practical men will, without more, take the risk of putting it into immediate commercial production and use? Second, would the time, effort and expense of conducting actual field experiments be unjustified because of the small likelihood that they would yield substantially greater knowledge concerning the product's performance?

Corroboration of the evidence of an inventor is required as stated above. If his own evidence could be held sufficient, there would be few ways in which it could be rebutted or disproved.[5] Hearsay and other self-serving evidences, such as opinion evidence, cannot be relied on alone. Indeed, there is a line of decisions requiring visual corroboration: that is the personal observation of the details of reduction to practice. As indicated above, a corroborative witness may be anyone sufficiently skilled in the subject to understand the invention, except a joint inventor. Notebooks not made by the inventor serve as corroborative evidence, but usually the oral statement of the writer is needed to get full value from them. Unsupported oral testimony by a witness is examined with extra care. It may be accepted, but the length of time elapsed since the occurrence is taken into consideration and a lapse of even one year may lessen the reliability greatly, although this depends on the memory of the witness.

The fact that an inventor has no corroborating witness is his own misfortune. It is wholly immaterial that an inventor's testimony is uncontradicted, plausible, persuasive, and even convincing when he has no corroboration. The testimony of an assistant, however, need not be corroborated, for in one such case it was held that, "It may be said that corroboration as to this exhibit was not, in fact, required to be made in the same manner that would have been required had it been made by the inventor himself."[6] The testimony of a wife needs careful examination since it is difficult to cross-examine her properly according to legal restrictions. A brother is more satisfactory as a witness.

The witness must be definite. Merely having seen or been shown a notebook is not sufficient. He must see and understand the critical element and note successful operation. In the case of Carter *vs.* Kellgren, *et al.*, the junior party established an actual reduction to practice before his filing date.[7] The inventors made an adhesive tape and found it satisfactory by test. One of the witnesses tested the tape and described the tests. He found the tapes satisfactory and as described. Additional witnesses also made tests.

In chemical cases it becomes necessary to establish beyond any reasonable doubt that the composition claimed was actually made. Fellner says, "The identity of compositions can be proved only by unequivocal chemical determinations. Nothing may be left of inference, speculation, or a discretionary selection of alternatives."[8]

The completeness of the chemical identification required depends on the particular case. The identity of the ester of phosphoric acid claimed by Mikeska

[3] SCHARMANN *vs.* KASSEL 636 O.G. 391 (1950).

[4] LARSEN *vs.* MARZALL, Commissioner of Patents 658 O.G. (4) 933 (1952).

[5] See KITCHEN *vs.* SOUTH 189 O.G. 255 (1913); or RIVISE, C. W. AND A. D. CAESAR, "Interference Law and Practice," The Michie Co., Charlottesville, Vol. III, sect. 541.

[6] KEEFE *vs.* WATSON 565 O.G. 523 (1944).

[7] CARTER *vs.* KELLGREN, TIERNEY, AND DREW 611 O.G. 5 (1948).

[8] FELLNER, I. J., *Chem. Eng. News*, **25**, 354 (1947).

was held established by an analysis for phosphorus, the amount of which was found very close to the "theoretical value," and by "solubility characteristics" of the product.[9] He was given a date of conception and reduction to practice "on a basis of experiments performed on his behalf by S.... a chemist employed by...assignee of Mikeska in which S.... testified to making the desired compound as shown by the analysis."

Mikeska failed to uphold an even earlier date of reduction to practice. His witness to the earlier experiments in which the analysis varied from the theoretical values explained that the variation was caused by impurities. This explanation was called "merely speculative" and, therefore, insufficient. His opponent had prepared similar compounds which were used as intermediates but were not analyzed and his evidence was, therefore, insufficient to distinguish between them.

In another case, the inventor, Thurston, failed to prove that he obtained his stated composition since he determined only C, H, N, but not O, nor were there other physical tests, except the determination of the melting point, to sustain the assumption that the product was the compound suggested.[10] The product was bottled by Thurston in the presence of Archer, marked, and sent out for analysis. Corroboration of the starting material would have helped. His witness, Archer, identified one of the starting materials by the label on the bottle taken from the laboratory shelf, but this was called insufficient proof of its contents. There was no corroboration that the material bottled in the presence of Archer was the same material received by the analyst, or that the material analyzed was that which was returned to Thurston. There should have been a witness to each step.

Another alleged reduction to practice involved an isomerization. The inventor failed to sustain the burden of proving by a "preponderance of the evidence" that the isomerization step was actually carried out.[11] The "crux of the case" lay in determining what happened to the intermediate in the second reaction. The opponents were able to suggest a different reaction, since the products were not analyzed, and the witness, who had the experiment carried out under his directions, only "knew" from experience and the literature (prior art) what would happen. However, the conditions were different from those of earlier workers, documentary evidence in the record of the experiment did not mention isomerization, and the specification could be interpreted in another way. Therefore, the judge could not feel that the evidence was certain enough to overcome the presumption of invention which is accorded the first to file his application.

Collins invented and applied for a patent on a method hastening the setting of gelatin.[12] Olsen believed he was really the first inventor and tried to prove his earlier actual reduction to practice or else his continued diligent development of his prior conception. Unfortunately for him there was

> nothing in the record to show that Fine at any time participated with Olsen in making any of the experiments or in doing any of the actual work, although it is disclosed by the testimony that Olsen did show Fine his results and that Fine said that Olsen frequently demonstrated his experiments and was generally familiar with the tests made. There is nothing to show that these experiments had to do with a substance that would conform to the count, nor is there anything to show that Fine was personally acquainted with what was accomplished by the experiments.

Fine recognized the importance of the problems; he received and understood the records; he accepted them and passed them along to Ferguson, who made tests in records that were

> so fragmentary and indefinite that from it we cannot conclude that Olsen's clear conception and definite disclosure was ever fully tested by anyone but Olsen and the record afforded no evidence of anyone satisfactorily verifying the tests which were made by Olsen. . . . We must conclude that statements in reports by Olsen, no matter how clear, as to what he used, what he did, and what the results were, cannot be accepted as proof of reduction to practice, unless properly corroborated, even though such reports were made to an official who had such confidence in their accuracy that he was willing to act upon them without complete and independent investigation. The records proved conception but not reduction to practice. In another strictly chemical case, the courts stated "we do not think that any material burden is imposed on any applicant for a patent to see to it that all of his work has been properly disclosed and explained to others who may be called as witnesses."[13]

In the case referred to by the decision[13] it is interesting that the defendant, Johnston, admitted that the junior party

> did everything that could be expected of a research chemist in the way of working out the subject matter of his invention and establishing the structural formulas of the compounds involved and in reporting the results to his associates and superiors.

But the court was unconvinced, and, in speaking of a corroborating witness for the junior party, Senkus, stated,

> He did not point out one specific experiment which he saw carried through and did not state that he observed at any one time, in proper consecutive order, the weighing out . . . the mixing of the formula, and the preparation of the crystalline product.... There is no evidence that the product resulting from the reaction mixture or the final product was analyzed.

In accordance with this "established doctrine" of clear, independent corroboration "in patent jurisprudence," the court ignored the evidence of analysis by independent analysts, utility tests, etc., unsupported by oral witness. "In order that a corroborating witness be properly equipped to give testimony in a case such as this, he surely must see the operation of the process and have personal knowledge of the product." The rule of law for corroborating evidence is that the actual records merely serve to remind the witness and that "the notebook entries and reports to others...are

[9] FARRINGTON, *et al.*, *vs.* MIKESKA 590 O.G. 3 (1946).
[10] THURSTON *vs.* WULFF, *et al.*, 607 O.G. 578 (1948).
[11] PINES *vs.* MCALLISTER 650 O.G. 624 (1951).
[12] COLLINS *vs.* OLSEN 503 O.G. 3 (1939); see also PATTERSON, ET AL., *vs.* CLEMENTS, ET AL. 557 O.G. 7 (1943) and LICHTENWALTER *vs.* CARON 598 O.G. 325 (1947).
[13] This internal quote is from SENKUS *vs.* JOHNSTON 611 O.G. 759 (1948).

merely self-serving in their character . . . there must be independent corroboration of all the essential factors concerned in reduction to practice."

In another case a report to a superior was not convincing because, as the decision stated,[14]

> . . . we are not convinced that the broad assertion by Hadler that he signed this typewritten report is sufficient corroboration of the subject matter of the counts. The assertion by Hadler . . . that it was usually his custom to review such reports is very general and uncertain that he examined any statement relevant to the particular matter involved in the counts.

The witness has to be definite and unequivocal in his recollection of particular critical events.

In a case involving the production of an ester of phosphoric acid, again the notebook alone was not convincing for, states the decision,

> . . . although Farrington, *et al* . . . had testified as to the Hirsch experiment, their testimony was merely based on the contents of a notebook allegedly kept by Hirsch. It does not appear that any of these witnesses had any independent recollection of the details of that experiment. The entire case of Farrington, *et al.*, therefore, as to the Hirsch experiments rests on the accuracy of an unverified notebook which was not identified by the person who allegedly made entries therein. Under the circumstances . . . Farrington, *et al.* have not introduced evidence which would justify a holding of conception or actual reduction to practice of the invention defined by count prior to the filing of their involved application.

However, when the witness can be definite, a notebook is convincing for, very recently, corroboration of the inventor's testimony was "satisfied where a verified report of the laboratory tests is put in evidence, without objection, and there is testimony that such report was contemporaneously received and considered." The fact that the opposition did not object to the reports as evidence seems to be a critical element in the decision.[15]

In general, diligence or continuity of development either before or after reduction to practice is a critical factor, but is primarily a problem of laboratory supervision and deserves separate treatment. Larsen did not file his application immediately after his actual reduction to practice.[15] The court said that such lack of diligence after reduction to practice can indicate lack of conviction that a product's utility has been proved and that the invention was, therefore, abandoned. It held, however, that Larsen was reluctant to launch a new product in wartime and also was looking for an asphalt mine. Further, there was no attempt at concealment although he did wait to file until just five days before a statutory bar occurred.

A possible procedure for maximum protection may be the appointment of an *alter ego* or shadow to follow and note each step so that he can swear that the applicant did not switch flasks while his back was turned and to prove that the analyst received the same material as produced by the applicant and that the analyst did not switch the materials, etc. A somewhat similar and better solution is to have another chemist carry out the procedure and analysis. Perhaps the simplest way to provide this on a firm basis is to ask a competent person to carry out the process according to your directions, either written or oral and make full notes of his experiment indicating the source of his original materials, his proof that the product obtained was that covered by the invention, if the invention does include product claims, and utility. If, for any reason, it is not possible to have a competent chemist carry out the invention, then it is important to carry it out oneself in the presence of a witness who can understand what is being done and can testify definitely and concretely as to the source of the materials, the steps and crucial details of the experiment, such as temperature, etc., disposition and testing of the product.

The notes should show analytical data and methods used to determine the identity of the starting material. Such information as melting point, specific gravity, and refractive index is often easily determined and would usually be satisfactory in corroborating the identity of the material. The same information should be obtained on the final production if it is part of the invention. There should be allowed no room for a suggestion that other materials could have been substituted by some sleight-of-hand or that the product was not that which the inventor describes.

It goes without saying that all of the material evidence should be present in the notes, which should provide a key to obtaining the necessary witnesses and other corroborating material from the company files kept in the regular course of business.

Although it has been suggested that, if carefully and imaginatively prepared, a satisfactory case could be built up to establish that research laboratory records should stand as corroboration of an inventor's testimony because of their character as records maintained in the ordinary course of business, it seems evident from the cases cited that there would be considerable difficulty in obtaining the assent of the higher courts. This is shown by the fact that in one case it was held that the "data sheets of themselves, not having been properly proved as to the accuracy of their contents, cannot be held as evidence of such contents" and are not records "in course of business" as meant by the U. S. Code, title 28, section 695.[16] In this case the superior rather than the analyst was called as a witness and he could not answer for the preparation of a catalyst used in test runs.

Another course is to file a rapidly drawn application in order to obtain the earliest possible date of constructive reduction to practice. The application may later be revised and a continuation-in-part filed where the material justifies a carefully drawn case. Such a procedure means a much greater load on the Patent Office, and requires that attorneys get used to preparing and filing poorly drawn initial applications.

[14] BRITTON, *et al.*, *vs.* HASS, *et al.*, 38 U.S.P.Q. 495–7.

[15] See footnote 4.

[16] TETER *vs.* KEARBY 617 O.G. 903 (1948).

DIVISION OF CHEMICAL EDUCATION

OF THE AMERICAN CHEMICAL SOCIETY

Treasurer's Report, March, 1953

Receipts:			*Expenditures:*		
Balance on hand 9/1/52		$1,279.74	A.C.S. Receipt Cards	$ 25.00	
Dues		17.00	A.C.S. mail separates, Fall, 1952, Meeting	47.09	
			Postage	21.00	
Received from F. D. Martin, 11/1/52 ($996.74 plus a			Help mailing bills	11.05	
$300.00 bond deposited with R. V. Mellefont)		$1,296.74	C. A. Vander Werf, Secretary, expenses	42.42	
Interest on bond	$ 3.75		O. M. Smith, Workshop Committee	200.00	
Dues previous to 1953	19.00		L. L. Quill, A.A.A.S. Coop. Committee	72.74	
Dues for 1953	530.00				
Dues paid in advance	170.00	722.75	Total expenditures		419.30
Total receipts		$2,019.49	Balance on hand		$1,600.19

Revision of Bylaws

RECOMMENDATIONS for the revision of certain sections of the Divisional By-Laws have been suggested by the Council Committee on Constitution and By-Laws. The report from the chairman of the Council Committee, listing these recommendations, follows:

Report On Bylaws of the Division of Chemical Education

The Bylaws of the Division of Chemical Education as submitted by the Executive Secretary with his letter of November 3, 1950, and as amended by the Division on September 6, 1951, were reviewed prior to the effective date of the amendments passed by the Council at its Spring, 1952, meeting. Included among these amendments was one lengthening the term of a Divisional Councilor from two years to three years. At the time of the review the Bylaws of the Division as amended on September 6, 1951, were considered satisfactory subject to incorporation of the following changes:

Bylaw II, Section 4. Delete "resign" and substitute "sever"; delete "membership in" and substitute "connection with."

These changes are recommended since an Associate does not have the status of membership in the Division. Accordingly he cannot "resign" his membership.

Bylaw III, Section 5(*c*). This section must be reworded in the light of the amendments adopted by the Division September 6, 1951. Bylaw III, Section 5(*c*), contemplates election during a business meeting of the Division as set forth in the old Bylaw III, Section 4(*a*). Since officers are now to be elected by mail ballot, a definite date must be set by the Division for the beginning of the term of newly elected officers.

Bylaw IV, Section 2(*a*). This section likewise needs to be reworded in the light of the amendments adopted September 6, 1951.

The Division will now find it necessary to revise its Bylaws to incorporate necessary changes providing a three-year Councilor term. Review of the Bylaws would indicate that further changes in Bylaw III and Bylaw IV will be necessary to provide for this change. It is recommended that the changes necessary to provide a three year Councilor term be made in addition to the changes recommended above prior to council approval of the whole document.

Our present Bylaw X, Section 1, states:

Amendments to these Bylaws may be made by a two-thirds vote of the active members voting, provided that one month's notice of the proposed amendment or amendments have been given. Notice may be made either by publication in the Journal of Chemical Education or in writing to the members of the Division. Amendments may be made at either the annual meeting of the Division or by a mail vote of all active members.

Section 2 of Article X states:

All amendments to these Bylaws must be approved by the Council of the Society.

My suggestion is that at the business meeting of the Division at the Chicago meeting this coming September, we vote on (and I hope approve) the revisions suggested by the Chairman of the Committee on Constitution and Bylaws.

The exact wording of the revisions will have to be worked out by a committee (probably the Executive Committee) prior to the business meeting of the Division. But I believe this memorandum fulfills the requirement of Article X, Section 1 quoted above, even though the exact wording cannot now be given.

PAUL H. FALL, *Chairman*
Division of Chemical Education

Officers Elected for 1954

Chairman: C. A. Vander Werf *Secretary:* G. W. Smith *Member-at-large:* W. H. Steinbach

A VISUAL DEMONSTRATION OF FRACTIONAL DISTILLATION

JAMES O. OSBURN
State University of Iowa, Iowa City, Iowa

IN TEACHING chemical techniques or chemical engineering unit operations, demonstrations are useful in creating interest and in aiding the student's memory. Demonstrations are also useful as a means of attracting new students to the field, and of interpreting the profession to the public. Teachers who are concerned with student recruitment or public relations are always looking for simple demonstrations which dramatically illustrate or explain the fundamental principles of chemical and engineering practices.

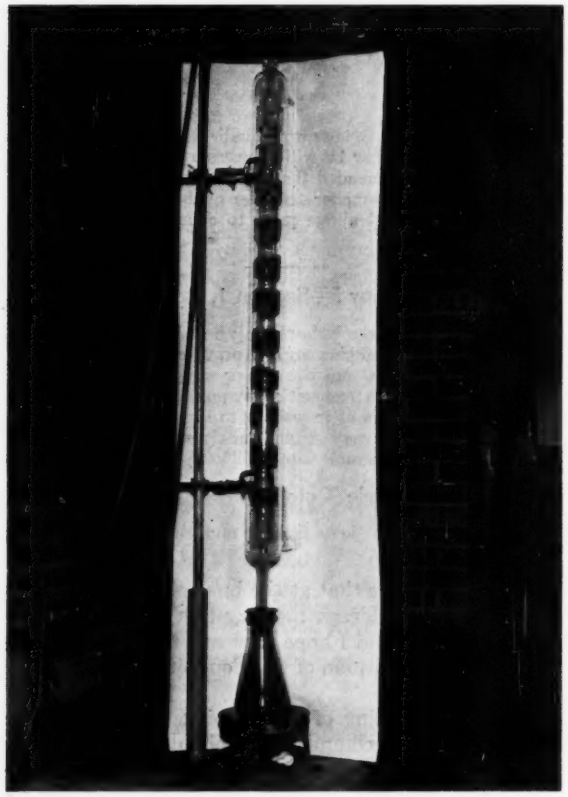


Figure 1. Demonstration Glass Bubble-Cap Distillation Column

One operation which has been a favorite for demonstrations is fractional distillation. This requires relatively simple equipment—a heat source, cooling water, and simple glassware. The audience can see the boiling taking place, the vapor bubbling up through the column, and the condensation taking place in the condenser. Glass bubble-cap columns are the most fascinating to watch, but a simple packed column can serve almost as well.

In the past the liquids used for the demonstration have been colorless liquids, such as alcohol and water. Although these liquids demonstrate very well the physical nature of the operation they fail to show what the distillation process is designed to do, which is to separate materials into fractions of different compositions. The demonstrator must explain that the concentration of the more volatile component is higher at the top of the column, since he has no simple way of showing this.

The demonstration can be greatly improved if one of the components is colored, so that anyone can see that the concentration is different at different points in the column. When such materials are used, the demonstration takes on added significance and interest.

A search for such a system to be used in a demonstration for an annual Engineering College Open House showed that other requirements should be met. Most important, the materials must be safe, both from the standpoint of inflammability and toxicity. They must be reasonably inexpensive. The boiling point must be within a certain range—if too high, the column will not operate without insulation; if too low, there will be excessive loss of vapor. It is preferable to have the colored material less volatile than the colorless one, since purity is associated with lack of color, and the demonstration is most effective if the "purest" material is at the top of the column. The relative volatility of the two substances must also be neither too great, which would keep all of the colored component in the still-pot, nor too small, in which case the concentration change through the column would be too small.

The number of colored substances with the right volatility is rather limited, but fortunately a pair of substances were discovered which meet all of the requirements listed. These are carbon tetrachloride and iodine. Although iodine is a solid, it has a high vapor pressure and dissolves in carbon tetrachloride to give intensely colored solutions. The vapor in equilibrium with such solutions contains an appreciable amount of iodine, enough to give it a violet color.

APPARATUS

This system has been used for demonstrations for several years, with excellent results. Two pieces of equipment have been used, both operating with total reflux. The first, shown in Figure 1, is a glass bubble-cap column constructed by the department glass blower a number of years ago. Glass columns similar to this are now available commercially. As can

be seen in the photograph, the change in concentration from one plate to the next is easily apparent. The concentration in the still pot is 1.9 per cent iodine by weight, and the liquid on the top plate contains only a trace of iodine. These concentrations may be varied, but this represents a satisfactory operating condition. A less expensive exhibit is shown in Figure 2. Here the fractionating is done in a glass tube filled with glass rings, and the color is seen to vary continuously along the tube. In this particular illustration the rings were cut from 4-mm. glass tubing with a glass-cutting saw; the exhibit could have been made just as well with glass beads, broken glass, or glass rings obtained from a supply house. A piece of glass wool at the bottom of the column supports the packing.

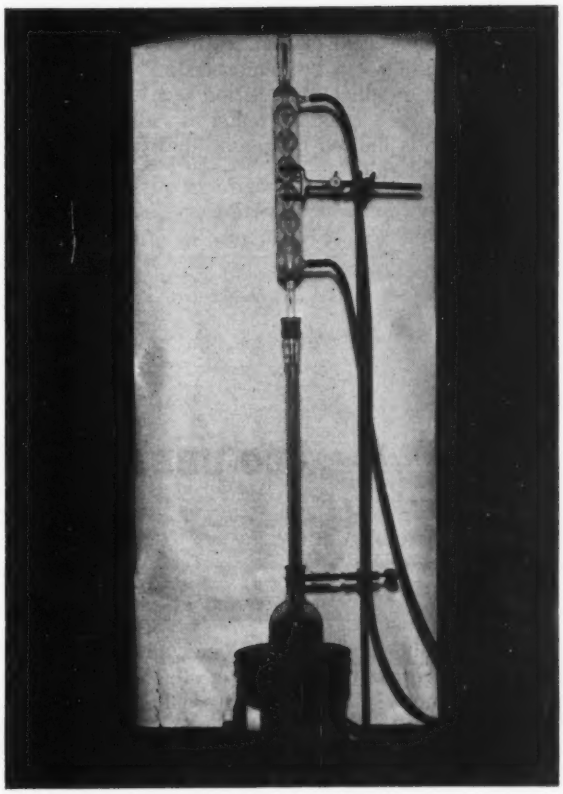


Figure 2. Demonstration Glass-Packed Column

EQUILIBRIUM DIAGRAM

The demonstration can be made even more instructive if a vapor-liquid equilibrium diagram for the system is available. Equilibrium vapor and liquid concentrations were measured for solutions of several different concentrations. For this, an Othmer still was used. The iodine was c.p. grade, and the carbon tetrachloride was a commercial grade boiling at 76°C. The samples were analyzed by titration with thiosulfate solution, with starch indicator.

Within the range of concentration studied, the equilibrium can be represented by Henry's law: $Y = kX$. With X and Y expressed in mol per cent of iodine in the liquid and in the vapor, the Henry's law constant, k, has the value of 0.26. This is at a substantially constant temperature of 76°C., since the small amount of iodine present does not change the boiling point very much.

Figure 3 shows the conventional equilibrium diagram for this system. Also shown on this chart are test tubes containing iodine solutions corresponding to typical compositions which would be obtained on adjacent plates in a bubble-cap column with 100 per cent efficient plates. The test tubes are lighted from behind, so that the concentration can be estimated from the amount of light transmission.

Suppose one starts with a 1.1 mol per cent solution in the flask. Its appearance is shown by the sample on the right, and it corresponds to a liquid composition as shown. The vapor composition is found from the equilibrium curve. This is done graphically by drawing the dotted line vertically until it intersects the equilibrium curve. If the column is operated at total reflux, everything comes down that goes up, and the liquid coming down from the second plate is equal in amount and composition to the vapor going to the plate. This condition is obtained graphically by drawing a line horizontally until it intersects the line representing the condition $X = Y$, which is the 45-degree line. This gives the liquid composition for the next plate, and the construction is repeated.

Liquid samples corresponding to four theoretical plates are shown, and the differences in concentration are readily apparent. At higher concentrations, the solutions are so dark that differences cannot be detected easily, and at lower ones, they are too light.

With the aid of this equilibrium diagram, and a series of solutions of known composition, it would be a simple matter to make a rough quantitative estimate of the individual plate efficiencies during the course of a demonstration. In a similar manner, batch distillation

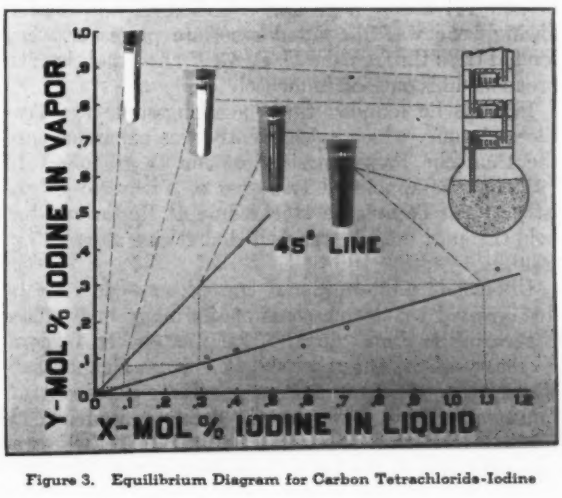


Figure 3. Equilibrium Diagram for Carbon Tetrachloride-Iodine

with less than total reflux can be demonstrated. The increased effectiveness of rectification compared with simple distillation can be demonstrated very vividly. The change in product composition as a batch distillation proceeds with constant reflux can also be shown, although this is limited by the solubility of iodine in carbon tetrachloride.

These materials may also be useful when it is desired to study the mixing of solutions. In watching the operation of the equilibrium still, it was interesting to watch the mixing of the condensed vapor as it was returned to the still and mixed with the liquid in the still. This could easily be observed due to the differences in color intensity.

LEO UBBELOHDE

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THE name Ubbelohde is world famous because of the accomplishments of this old master of petroleum chemistry, who now is living in Düsseldorf am Rhein. Though well along in his seventh decade, he is still mentally alert and retains his indefatigable urge to work.

Leo (Carl Eduard) Ubbelohde was born at Hanover on January 4, 1876. He studied at the University of Berlin and also at the Berlin Technische Hochschule. After a few years in industry he returned to the University where he took his Ph.D. in 1903. His principal teachers were Landolt and Wichelhaus; his doctorate thesis dealt with an organic topic. Following a term as assistant at the Materialprufüngsamt in Berlin, which was then under the direction of D. Holde, Ubbelohde went to the Technische Hochschule at Karlsruhe in order to be associated with Carl Engler. He became Privatdozent at Karlsruhe in 1910 and the following year was appointed associate professor. Extended trips through the U. S. A., France, and Sweden broadened his outlook immensely.

In 1915 he founded the Forschungsstelle für Textilersatzstoffe, which subsequently was expanded into the Deutsche Forschungsinstitut für Textilstoffe. In 1933 he was appointed Professor of Technical Chemistry at the Technische Hochschule at Berlin and has held this post until he reached the retiring age of 65 in 1940.

Ubbelohde's international connections can best be documented by stating some of the many high offices that came to him. In 1907 he was chosen General Secretary of the International Petroleum Commission, which he organized in that year. His exceptional administrative ability was amply demonstrated in connection with this important body. In 1913 he was vice-president of the London meeting of the Illuminating Engineering Society; in 1924 he became corresponding member of the Erdöl Union in Vienna; and in 1932 he was named honorary member of the Institute of Petroleum Technology in London. He served as vice-president of the World Petroleum Congress at its London meeting in 1933, and that same year he became the first president of the Deutsche Gesellschaft für Mineralölforschung. The Lenard Medal and the prize of the Kolloid Gesellschaft were awarded to him in 1936. In 1937 he was again vice-president of the World Petroleum Congress in Paris and was also made life honorary member of the Association Française des Techniciens du Pétrole in Paris. He was made a member of the permanent council of the World Oil Congress in 1938, and this same year brought him honorary life membership in the Academy of Sciences at Bucharest. The Institute of Petroleum Technology in London elected him Honorary Fellow in 1950.

Numerous patents of the highest quality were issued to him. Well above 100 papers contain the record of his rich and varied researches. His "Zur Viskosimetrie," which has gone through five editions, is still popular. The four-volume "Handbuch der Chemie und Technologie der Öle, Fette, Wachse und Harze" has had a wide distribution. He has furnished valuable sections to such works as Dammer's "Chemische Technologie der Neuziet," Engler's "Das Erdöl," Post-Neumann's "Chemische-Technische Analyse," etc.

His publications have dealt mainly with mineral oils, fats and soaps, gases, coal, paper, and textiles. His viscosimeter with the suspended level, his drop-point apparatus, his process for curling smooth textile fibers, would of themselves have been sufficient to constitute a lasting memorial to this outstanding chemist.

As a teacher, he inspired many of his students to g

forward in science, and his advice is responsible for the selection of special fields of interest by many who were privileged to know him academically. He always emphasized the human relation between teacher and student; he made a point of the need for them to exchange opinions freely.

However, his interests and efforts have extended far beyond the bounds of chemical research and the practical applications of the science. He has always devoted much attention to economic and social-political problems. The plight of the unemployed has appealed especially to his humanitarian instincts; in 1914 he headed the relief section of the Badische Rote Kreuz and its assignee, the Arbeitshilfe.

With prophetic vision, and often against the tendencies of the times, he emphasized to his audiences that the treasure of science is the only form of wealth which does not need to be hoarded and guarded anxiously against the designs of others. Use does not diminish this treasure, but rather increases it. Consequently, he maintains strongly that the union of science and technology should be cultivated internationally so that the greatest possible progress may be secured through comparison of achievements without regard to national boundaries and peoples.[1]

[1] A monograph "Leo Ubbelohde, sein Wirken" was published by his students, colleagues, and friends at Karlsruhe (Verlag Braun) in 1952.

GLASS IN THE BIBLICAL LITERATURE[1]

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Pittsburgh, Pennsylvania

As far back as Genesis 4, 22 there is the statement: "And Zillah, she also bore Tubal-Cain (eighth man after Adam), and instructer (whetter) of every artificer in brass and iron." If brass and iron were produced, slags necessarily formed. Slags are crude glasses.

While the references to glass are rather limited, a search of the biblical literature was rewarding in an auxiliary fashion. Especially in the Apocrypha were legends discovered which the authors had not previously encountered. They were interesting and sometimes very beautiful.

Glass, as it is known in the world today, is taken for granted. Few realize that it played an important role in biblical times. Evidence of its use was found in the following excerpts from the old and new Testaments.

Job 7, 18: "Hast thou with him spread out the sky which is strong and as a molten *looking glass?*"

Job 28, 12–7: "Where shall wisdom be found and where is the place of understanding? Man knoweth not the price thereof neither is it found in the land of the living. The depth saith—it is not in me; the sea saith, it is not with me. It cannot be gotten for gold, neither shall silver be weighed for the price thereof. It cannot be valued with the gold of Ophir, with precious onyx or the sapphire. The gold and the *crystal* cannot equal it, and the exchange shall not be for jewels of fine gold." The term "crystal" has been interpreted as glass by biblical scholars.

Psalm 56, 8: "Thou tellest of my wonderings; put thou my tears into thy *bottle*." Tear bottles were unearthened in Jerusalem. They were employed in Egypt in ancient times, as tears were considered sacred.

Psalm 119, 83: "For I am become like a *bottle* in the smoke, yet I do not forget thy statutes." Although many bottles in those days were made of skins, this evidently referred to glass.

Isaiah 3, 18–23, concerning the punishment of women for their false pride: "In that day, the Lord will take away the bravery of their tinkling ornaments about their feet and around tires like the moon, the chains and bracelets and the muffers, the bonnets and the ornaments of the legs, and the head bands and the tablets and the earrings, the rings and the nose jewels, the changeable suits of apparel and the mantles and the wimpels and the crisping pins, the *glasses* and the fine linen, and the hoods and the veils."

1 Corinthians 13, 12: "For now we see through a *glass* darkly but then face to face; now I know in part, but then shall I know even as I am known."

2 Corinthians 3, 18: "But we all, with open face beholding as in a *glass*, the glory of the Lord, are changed into the same image from glory to glory as by the spirit of the Lord."

General Epistle of James 1, 23: "For if any be

[1] Presented at the 123rd Meeting of the American Chemical Society, Los Angeles, California, March 17, 1953.

hearer of the word and not a doer, he is like unto a man beholding his natural face in a *glass*, for he beholdeth his way and straightway forgetteth what manner of man he was."

Revelation 4, 6: "And before the throne, there was a sea of *glass* like unto crystal and in the midst of the throne and about the throne were four beasts full of eyes before and behind."

Revelation 15, 2: "And I saw as it were a sea of *glass* mingled with fire; and them that had gotten the victory over the beast and over his image and over his mark and over the number of his name stand on the sea of *glass* having the harps of the Lord."

Revelation 21, 18: "And the building of the wall of it was of jasper and the city was pure gold like unto clear *glass*."

Revelation 21, 21: "And twelve gates were twelve pearls, every several gate was of one pearl and the street of the city was pure gold as it were transparent *glass*."

The Apocrypha.[2] Ecclesiasticus 12: "Though he humble himself and go crouching, yet take good heed and beware of him and thou shalt be unto him as if thou hast wiped a *looking glass* and thou shalt know that his rust hath not been altogether wiped away."

The Talmud.[3] One reference mentions the fact that the walls of Paradise are of *glass*.

[2] Religious writings of uncertain origin, usually not included in Protestant editions of the Bible.

[3] The body of Jewish civil and canonical law.

Another reference: "When Moses assigned the land to the twelve tribes, he assigned to Zebulon the sea coast whose prosperity would come not only in commerce, but which might yield them costly fish and the purple shell and the *sand* of whose shores might furnish them the material for *glass*."

Another reference: "Among the wonders of King Solomon's realm which the Queen of Sheba saw, was a house which he had built of *glass*."

Although few references to glass are found in the Talmud, the Jewish Encyclopedia published by Funk and Wagnalls in 1916 contains the following: "By Talmudic times, the Jews seem to have acquired the art of glass blowing. It is referred to as being practiced by them near Belus known for its sand. White glass was very dear; it is even stated that its manufacture ceased after the destruction of the second temple. The poorer classes used colored glass. A remarkable number of articles were made wholly or partly of glass; *e. g.*, tables, bowls, drinking vessels, bottles, beads, lamps, beds, weights, knives, cradles. These were sold by weight. Mirrors were usually of metal but glass ones are referred to."

And so we see that in the scheme of living in biblical times, glass played a significant role, side by side with gold, silver, brass, and the precious stones.

ACKNOWLEDGMENT

The authors gratefully acknowledge the cooperation of Reverend and Mrs. Solomon B. Freehof.

THE SELF-EDUCATION OF THE YOUNG ENGINEERING TEACHERS

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THE Young Engineering Teachers have been actively engaged in a campaign of self-improvement in a formal fashion for the past four years. In 1949 Dean Freund, the President of the American Society for Engineering Education, appointed five members to organize a Committee for Young Engineering Teachers. Since their first meeting at Rensselaer Polytechnic Institute, during the A. S. E. E. Convention, the Committee, with its current executive leadership of four and its 16 sectional sub-chairmen, has grown exponentially.

The main reason for this growth is that the Committee is attempting—and doing a good job at it—to fulfill the wishes of those members of the A. S. E. E. who consider themselves young in age and young in teaching experience. The Committee operates, like the Society, on three levels: nationally via correspondence, reports, and sessions at the annual meetings; sectionally (it should be noted that the A. S. E. E. is divided into 16 geographicals ections) via correspondence and conferences at the semiannual sectional

[1] Formerly Chairman, Committee for Young Engineering Teachers of the American Society for Engineering Education, and Assistant Professor of Chemical Engineering, University of Delaware.

meetings; and locally by means of seminars, conferences, classes, etc., varying from institution to institution.

From the Rensselaer meeting came these words in 1949: "There appears to be a need in the Society [*viz.*, the A. S. E. E.] for an organization in which the younger members of the engineering teaching profession can find assistance, expression, and responsibility in the advancement of themselves and the Society. A high percentage of the membership of the Society consists of teachers in the lower ranks."[2] This editorial served as a report to the membership-at-large of the A. S. E. E. from the five men appointed by Dean Freund. Specific objectives of the Committee as envisioned by the organizing committee were to provide young engineering teachers with:

(1) An understanding of the general goals and responsibilities of the dual professions of engineering and education.
(2) Orientation into the history and "unwritten laws" of the profession of engineering education.
(3) Guidance in their personal professional development.
(4) Acquaintance with the most effective instructional materials and methods, with methods of evaluating student achievement, and with the elements of counselling and student guidance.
(5) A means of exchanging ideas with their contemporaries.
(6) Stimulation.
(7) Dissemination of professional ethics.

The Committee discarded its diapers and put on rompers at the 1950 annual meeting of the Society at the University of Washington. Here it held a business meeting and then a technical conference with approximately 15 members in attendance. At this conference session three papers were presented, two being by young men who were then assistant professors. The 15 men present constituted themselves the Executive Committee, elected a Chairman and drew up a plan of action for the year 1950–51.

The main formal activity of the Committee following the 1950 meeting consisted of building interest nationally in connection with the Committee's program. This was done by a questionnaire set to every engineering school. Like many questionnaires, only a small number of answers were received, namely 25, ranging from laconic one-word replies to verbose three-page discussions. Sectional activities were nonexistent in this period. At least two local activities, unsponsored by the Committee but fitting firmly in its program, took place—a series of seminars at New York University directed at improving teaching in engineering, and a course in the fundamentals of teaching presented to the younger staff members of the College of Engineering at the State University of Iowa.

In 1951 the Committee for Young Engineering Teachers broke into print three times at the annual meeting at Michigan State College. Of prime interest was a luncheon the Committee sponsored where an audience of about 50 participated vigorously in a discussion of "The Road to Advancement — Teaching *vs.* Research *vs.* Advanced Degrees *vs.* Industrial Experience." In addition to this activity the Committee participated in joint technical sessions with the Committee on Improvement of Teaching and also with the Committee on Teaching Aids.

The 1951–52 school year saw the Committee in long pants, operating on all three levels. Two progress reports were issued by the author and distributed to all engineering schools. In approximately half of the 16 sections, the Committee had an active voice in one or more sessions of the section's meetings. This mainly took the form of round table discussions or papers by younger members. In one section it was reported that though the session held by the Committee was one of six technical sessions held simultaneously, it had by far the largest attendance of all sessions. On the local basis, at least 12 schools reported activities ranging from monthly seminars to guest lectures. The culmination of the 1951–52 year came at the annual meeting at Dartmouth College where all seven objectives of the Committee were dealt with. The Committee held a picnic dinner, complete with "bull-session," a luncheon and business meeting, a joint technical session with the Committee for the Improvement of Teaching, and a technical conference where four Committee members presented papers. The Committee thus gave the young engineering teacher present at the meeting a center for his activities—a locus for his interests to prevent his getting lost among a group of persons well known to one another but, in many cases, unknown to and distant from the young man.

How young is young? That question has plagued the Committee since its inception. It has been resolved in keeping with the famous adage, a man is as young as he feels. Thus, there are no age or rank restrictions to membership or participation in the Committee. However, it was the feeling at Dartmouth that the leadership of the Committee should rest in the hands of those who are either below the rank of full professor or below the age of 38 but no formal bylaw exists to that effect.

Where will the Committee go in 1952–53? Under the able leadership of Professor Roger Sampson of the University of Florida a "call to stations" has been sent to all 16 sectional sub-chairmen. Professor Sampson now has a vice-chairman for local activities and a vice-chairman for sectional activities, both able men with splendid records of accomplishment in the Committee's work. This year the Society itself is giving great impetus to the Committee by sponsoring a prize-paper contest for young engineering teachers with a first prize of $300 and a second prize of $200.

The words of Professor Sampson in his letter to the sectional sub-chairmen indicate the progress to be expected of the Committee this year: "The existence of the Committee is justified primarily as a means for individual young engineering teachers to find assistance, expression, and responsibility in the advancement of themselves as individuals and of their profession as a whole."

[2] SCHWARTZ, F. L., "Young Engineering Teachers, an editorial," *J. Eng. Educ.*, **40**, 407 (1950).

THE MONTHLY LIST OF RUSSIAN ACCESSIONS[1]

SONYA G. MACHELSON
Washington, D. C.

THE *Monthly List of Russian Accessions* is a record of publications in the Russian language issued in and outside of the Soviet Union which are currently received by the Library of Congress and a group of cooperating libraries. Some Soviet publications printed in languages other than Russian are also included.

The first issue appeared in April, 1948. It consisted of two parts. Part A listed monographs published since 1945; Part B listed the contents of Soviet periodicals published since 1947. Both parts were transliterated. Sometimes translations of the contents of certain periodicals were made available to the Library of Congress, and in that case the titles appeared in English. Unless otherwise indicated, all listed entries are represented in the collections of the Library of Congress. Symbols representing other libraries are given in the introductory note.

The interest of scholars and research workers in publications emanating from the Soviet Union has increased greatly during the past few years. Requests have been made for more information about articles in Soviet periodical literature; and by readers with little or no knowledge of the Russian language, for more English translations. To satisfy these demands, the *Monthly List* was expanded, beginning with the March, 1952, issue. This issue consists of four parts: A, B, C, and D.

Part A containing monographs only, lists author, English translation of the title, transliteration of the Russian title, publishing house, date of publication, and number of pages. Part B gives a transliterated table of contents of periodicals. Part C is a subject index to the periodical articles listed in Part B. The title of each article is translated into English and listed under the appropriate subject heading. Part D lists publications known to have appeared recently in the U.S.S.R. but not reported to be in any library in the United States. The English translation of the title is included. However, Part D is being conducted as an experiment only. So far, few libraries have shown interest in it, and it may be discontinued shortly.

Starting with the September, 1952, issue, monographs are listed under appropriate subject headings in Part C. Part B includes the table of contents of periodicals both in the translated and transliterated forms.

At the present time, the *Monthly List* covers about 500 books and 250 periodicals per month. The parts A, B, and D are subdivided into 17 classes, namely: general and reference works, bibliography, agriculture, education, fine arts, geography and geology, history, language, literature and folklore, law, medicine, military and naval sciences, music, theater and motion pictures, philosophy and religion, political science, science, social sciences, and technology.

The scope of the material covered by the *Monthly List* is wide. There are quite a number of children's books and magazines which receive considerable attention from American educators; various periodicals such as *Printing Industry, Agrobiology, Fisheries.* The fine arts are represented by *Architecture of the U.S.S.R. Art,* etc. There are quite a few periodicals on medicine, geology, geography, history, economics. Linguistics too is well represented, and you will find even a fashion magazine.

A number of books and periodicals in the field of science and technology are covered. Let me mention just a few of them: Publications of the Academy of Sciences, U.S.S.R., such as *Izvestiya and Doklady; Scientific Records of the University of Moscow; Colloid Journal; Advances in Chemistry; Journal of General Chemistry; Journal of Applied Chemistry; Advances in Physics; Journal of General Biology; Veterinary Medicine; Soil Science.*

As compared with periodicals published in the U. S. A. Soviet periodicals appear in small editions. For instance, only 750 copies of the *Ukranian Biochemical Journal* are published, and 800 copies of the *Ukranian Chemical Journal.* It seems to me that the Library of Congress is doing a splendid job by acquiring these publications.

In addition to Soviet publications, about 20 periodicals published in the Russian language outside of the U.S.S.R. are also included in the *Monthly List.* They deal with specific problems of the emigrés or are of religious nature.

By an agreement with the All-Union Lenin Library in Moscow, cards showing some of their acquisitions are being received sporadically from that library. The cards give author, title, and publication date of each book as well as a brief summary of its contents. As I understand, these titles will be included in Part D of the *Monthly List,* if these books have not been reported as being received in the U. S. A.

Now a few words about translators and translating. I am sure that quite a few chemists have encountered difficulties owing to inaccurate translations. Good translators are rare, since they must have a thorough knowledge of the original language, an adequate background to understand what the article is about, and a

[1] Presented at the 122nd Meeting of the American Chemical Society, Atlantic City, New Jersey, September, 1952.

good knowledge of the English language, to be able to present a clear English version. Let me cite a few examples of translations I have come across.

A certain Ph.D., but not a chemist, with a limited knowledge of the Russian language, translated a chemical article. Here is one sentence: "The solution was titrated with *solyanaya kislota* (hydrochloric acid)." The translator confused *solyanaya kislota* with *sol'* (salt) and wrote: "The solution was titrated with salts of carbonic acid." (Where the carbonic acid came from, I wouldn't know).

Another Ph.D., an organic chemist, translated a German article on agricultural chemistry. He confused *weissen* (white) with *Weizen* (wheat), and instead of "wheat worm" he wrote "white worm" which quite alarmed the recipient of the translation, an agricultural chemist.

A translator who knows Russian quite well but has no scientific training once translated *Denaturatsiya proteinov* (denaturation of proteins) as "denaturalization" of proteins.

Another one had to translate *gribki* (fungi). He could not find *gribki* in his dictionary but he found *grib* (mushroom), and he translated *gribki* as "domestic mushrooms."

Now you can see what the editor has to cope with. By and large, translations in the *Monthly List* are quite accurate. But if you should find an occasional—shall I say, slip of the dictionary?—you will understand how it happened.

The *Monthly List of Russian Accessions* lists about 5000 entries per month which amounts to 60,000 entries a year. Over 50 per cent of the periodicals are scientific. Quite a few periodicals are reported on within two or three months after their publication in the Soviet Union.

CARBONATE ALKALINITY INDICATORS

MAXEY BROOKE
Old Ocean, Texas

It is not known here just when volumetric methods were first introduced into the course of quantitative analysis. But since that time, most students have been introduced to the subject by acidmetry. And most students have standardized their acid against sodium carbonate using methyl orange as an indicator. Further, a large percentage of these students have complained about the difficulty which they experienced in observing the end point.

If a survey were made it would probably show that there are more titrations made to the carbonate end point than any other type.

Although it has long been used and adopted as a standard (*1*) methyl orange leaves much to be desired as a carbonate end-point indicator. The color change from yellow to light orange makes determinations difficult to reproduce. It has been shown to have a pH color response in disagreement with the equivalence point for complete neutralization.

Water chemists in particular have done considerable work in attempting to obtain an indicator with a more distinct end point. In general, three lines of attack have been made. Modified indicators in which other dyes such as bromocresol green, xylene cyanole FF, or

TABLE I

No.	*Dye*	*g./liter*	*Solvent*	*Alkaline color*	*Acid color*	*Ref.*
1	Methyl orange Bromocresol green	0.040 0.200	Water	Blue-green	Red-violet	(*5*)
2	Methyl orange Xylene cyanole FF	2.000 2.800	50% Ethanol	Green	Magenta	(*6*)
3	Methyl orange Indigo carmine	2.000 6.000	Water (make separate solutions)	Yellow-green	Violet	(*9*)

TABLE 2

No.	*Dye*	*g./liter*	*Solvent*	*Alkaline color*	*Acid color*	*Ref.*
1	Methyl red Bromocresol green	0.200 1.000	95% Ethanol	Blue	Pink	(*3*)
2	Methyl red Methylene blue	1.250 0.825	"	Green	Violet	(*8*)
3	Methyl red Guinea green	0.750 0.625	"	Green	Violet	(*8*)
4	Methyl red Xylene cyanole FF	0.500 1.250	"	Green	Violet	(*8*)
5	Methyl red Alphazurine	0.750 0.625	"	Green	Violet	(*8*)
6	Methyl red Indigo carmine	0.750 0.937	"	Green	Violet	(*8*)
7	Methyl red, sodium salt Alphazurine	0.450 0.550	"	Green	Purple	(*4*)
8	Methyl yellow Methylene blue	0.800 0.040	"	Yellow-green	Pink	(*2*)
9	Dimethyl yellow Bromocresol green	0.400 1.600	"	Blue	Yellow	(*7*)
10	Sodium alizarin sulfonate Methylene blue	5.000 0.625	"	Red	Yellow	(*8*)
11	Sodium alizarin sulfonate Guinea green	5.000 0.625	"	Red	Yellow	(*8*)
12	Sodium alizarin sulfonate Xylene cyanole FF	5.000 1.250	"	Red	Yellow	(*8*)
13	Sodium alizarin sulfonate Alphazurine	5.000 0.325	'	Red	Yellow	(*8*)
14	Sodium alizarin sulfonate Indigo carmine	5.000 1.250	"	Red	Yellow	(*8*)

indigo carmine are added to methyl orange to make the color change more distinct. Examples of this type are given in Table 1. Mixed indicators consist of two dyes, one of which undergoes a color change slightly below the desired pH and one which undergoes a color change slightly above. Approximate mixtures give sharp color changes at the carbonate end point. Examples of this type are given in Table 2. Mixture No. 1 is widely used in industry. The third method is substitution, a problem of finding an indicator which gives a color change at the same point as does methyl orange but has a sharper end point. Several of these have been reported in the literature and are shown in Table 3. Since none of these materials is available commercially, they have not been widely used. This presents a fertile field for an advanced research project.

Having students prepare and compare these indicators serves a useful purpose. It will acquaint them with the fact that methyl orange is not the only indicator for carbonate titrations nor is it the best one. It will stimulate their interest in the theory of indicators. And in allowing them to exercise some judgment in the selection of the best indicator, it will make their introduction to volumetric analysis more interesting.

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(*10*) Taras, M., *Anal. Chem.*, **19**, 339–41 (1947).

(*11*) Taras, M., *ibid.*, **20**, 680–1 (1948).

(*12*) Taras, M., *J. Am. Water Works Assoc.*, **41**, 527–31 (1949); *Chem. Abstracts*, **43**, 5519.

TABLE 3

No.	*Dye*	*g./liter*	*Solvent*	*Alkaline color*	*Acid color*	*Ref.*
1	4,4′-bis(*p*-dimethylamino phenylazo)-2,2′-stilbene disulfonate	1.0	0.05 *N* (NaOH)	Orange	Blue	(*10*)
2	4,4′-bis(*p*-tolyltriazeno)-2,2′-stilbene disulfonate	1.0	0.05 *N* (NaOH)	Yellow	Muddy	(*10*)
3	Hessian purple N extra	1.0	0.05 *N* (NaOH)	Faint mauve	Purple	(*11*)
4	di-sodium 4,4′-bis(4-amino-1-naphthylazo)2,2′-stilbene disulfonate	1.0	Acetone	Pink	Blue	(*12*)

Proceedings of the

PACIFIC SOUTHWEST ASSOCIATION
OF CHEMISTRY TEACHERS

THE RECYCLING OF FISSION PRODUCTS IN THE BIOTIC CYCLE[1]

J. M. HESLEP and A. W. BELLAMY
Office of Civil Defense, Sacramento, California

THE Radiological Services of the State of California, Office of Civil Defense are concerned with all aspects of radiological hazards to the people of California. The more obvious of the hazards are those arising subsequent to enemy attack involving atomic weapons. Less obvious but nonetheless important, are potential hazards arising from the rapidly expanding use of radioactive materials for research, industrial, medical, and other purposes.

Following atomic attack, we would be faced with a tremendous task of rehabilitation as a result of physical damage of blast and heat. There would be large numbers of casualties to be cared for. Yet these tasks, as great as they may be, are comparatively straightforward. The problems to be discussed in this paper are far from straightforward. The dangers are difficult to detect; even more difficult to assess.

The problems include:

(1) The physicochemical behavior of fission products in the several important soil types, diffusion, percolation, ion exchange, and, in general, all of the factors that affect availability of the fission products to plant root systems.

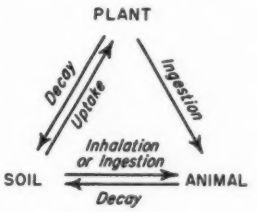
(2) The physicochemical behavior of fission products in fresh and sea waters and definition of conditions affecting the availability of water-borne radioactivity to foods coming from aquatic sources.

(3) Factors affecting the uptake and retention by animals of air-borne radioactivity.

(4) The behavior of fission product isotopes in various chemical combinations in plant and animal metabolism, and their micro- and macrobiological effects.

(5) Methods of decontamination of large areas—urban and suburban.

We will proceed to discuss certain aspects of these problems in some detail. Before doing so, it should be stressed that the concern here is not with external whole-body radiation, as would be the case immediately following an atomic burst, but rather with radioactive *contamination* which is likely to be transferred into the human body by ingestion or inhalation, or through open wounds.



The Biotic Cycle

The figure shows a much simplified schematic diagram of the biotic cycle. This cycle as it pertains to such elements as carbon, nitrogen, sulfur, and phosphorus is absolutely essential to plant and animal life. Our interest is the place in the cycle of radioactive materials arising from nuclear detonations, radiological warfare, or expanding peacetime uses. Further, the interest is in damage to or destruction of life, rather than its maintenance.

The cycle as pictured here is perfectly straightforward, with one minor though important exception. This is the line showing the direct entrance of soil into animals—including man, of course—by way of inhalation or ingestion.

Ingestion is of principal concern with respect to those animals which feed directly on vegetation growing in the field. Animal-husbandry experts inform us that grazing cattle ingest astonishingly large quantities of soil along with grass. The implication of this is immediately apparent when one considers radioactive fall-out settling on the surface of the ground, as well as on whatever is growing there. Even though many of the radioactive isotopes are known to pass through the digestive tract with little absorption, good information is still lacking on the behavior of all of the fission products of biological significance.

In California we are paying particular attention to air-borne radioactive contamination which is subject to inhalation. We have taken advantage of weapons tests in Nevada to trace the dissemination of radioactive aerosols over the state, as well as to develop techniques for the collection and measurement of air-borne activity. We are equipping a fleet of mobile radiological laboratories, one of the chief functions of which will be to make rapid and accurate checks of air contamination, especially following atomic attack.

[1] Based on an address at the Spring Meeting of the PSACT, San Diego, May 10, 1952. Revised by the authors, March 20, 1953.

Let us examine some of the variables associated with the problem that concerns us in order to point out the types of information needed. The entire problem has been stated in a single complex question: What plants can absorb what fission products from what soil types and store them in what edible portions in such chemical forms and amounts that the fission products can be transferred to man or domestic animals, and with what effects? There may be times when the concern will be for other materials than fission products, but these are used as an illustration.

THE ISOTOPE

What are the fission products which are of major concern? There are more than 60 primary products of slow neutron fission of uranium 235. The range of mass numbers is from 72 to 158. Some 97 per cent of the fission products fall into two groups, a "light" group with mass numbers from 85 to 104, and a "heavy" group, with mass numbers from 130 to 149. The pattern for like fission of plutonium 239 is quite similar.

It is not known what changes occur in these results when fast neutrons, such as are produced by atomic bombs, are used. Consequently, some caution must be used in predicting fission yields from a bomb using slow neutron fission as a basis for comparison.

There are three criteria by which a given fission product can be biotically judged, so to speak: its yield in the fission process, its half-life, and its biological absorption and retention.

The yield factor is self-explanatory. The more of an isotope produced in fission the more of it available for damage to biological systems.

The half-life factor is an important one. In effect, the half-life of an isotope is the time required for one-half of its radioactivity to be dissipated. Half-lives of the various fission products vary from fractions of a second to many years. As a thumb rule, about 8 to 10 half-lives are required to reduce the radiation from commonly occurring amounts of an isotope to a point where it is no longer significant. Thus, it can be seen that fission products with half-lives under a few days would cause no long-range problems. Those with half-lives of around a month are likely to be troublesome for a year, and so on up the scale.

Biological absorption and retention of fission products are complex questions where, again, good information is scant. As it turns out, none of the principal fission products is otherwise nutritionally important. Consequently the backlog of information we have on such elements as calcium, phosphorus, iron, etc., is of little value in this connection, except for comparative purposes. Several of the medium and long-lived fission products are from the rare-earth group—those elements that we know least about. Lanthanum, cerium, praseodymium, and promethium fall in this group. Strontium, cesium, ruthenium, zirconium, and unfissioned plutonium are also of concern.

What facts are available indicate that plutonium and strontium may present the greatest hazards. Both are long-lived and are bone seekers. In the bone their radiation tends to destroy the sensitive bone marrow, one of the important blood-producing systems of the body. Strontium may be the worst. Its oxide is relatively soluble; its chemistry follows fairly closely that of calcium in soils, in plants, and in animals. It can be concentrated from soils by plants and thereby transmitted to animals. The proportion of Sr^{90} in fission products is not necessarily the same for fast and slow neutron induced reactions.

In case of a surface or subsurface nuclear detonation, in addition to the fission products, there is a problem of neutron induced radioactivity in constituents of soil and water. Neutron interaction with oxygen, nitrogen, and hydrogen yields mainly stable products, fortunately. Silicon and aluminum, major constituents of soil, form radioactive products from neutron bombardment, but with half-lives of only 3 hours and 2.5 minutes, respectively. Sodium and chlorine, constituents of both soil and sea water, are also made radioactive, but again with half-lives of 14.8 hours and 38.5 minutes. Detonations giving rise to very high neutron fluxes, however, may cause induction of fairly large amounts of longer lived material from some of the lesser soil and water constituents.

Nor must the possibility be overlooked of encasing a bomb in such a material that would give rise to considerable quantities of long-lived neutron-induced radioactive material. Still another possibility, radiological warfare, must also be considered. This refers to the spread of radioactive materials without resorting to explosion of a bomb. Both of these involve technical difficulties and estimates of enemy strategy, but they cannot be dismissed without serious consideration.

THE SOIL

Let us pass now to the second variable, the soil. A brief examination of some general characteristics of soils will perhaps show their importance in this problem.

The reactive portion of mineral soils (as opposed to organic or peat soils) is concentrated in the clay fraction; *i. e.*, in those particles of less than about 2 microns in diameter. Clay minerals are crystalline in structure, and usually termed alumino-silicates. This is because they are composed of layers of silica tetrahedra and aluminum octahedra. There are two major classes of clay minerals. One is composed of a layer of silica and a layer of alumina. The second consists of two layers of silica with a layer of alumina between. There are endless variations of these basic types caused by isomorphic substitution of ions in the crystal layer lattice. Differences in clay minerals are responsible for differences in both chemical and physical properties of soils.

The two most important properties of soil clay minerals are their enormous exposed surface, and the possession of a highly negative charge. This negative charge is balanced by adsorbed cations. As a result there is established a diffuse electric double layer, with a high concentration of cations near the clay particle,

becoming less concentrated with distance from the particle—the source of negative charge.

One of the two most significant of the processes that occur in soils is that of cation exchange. This process is responsible for furnishing a continuing supply of nutrients to plant roots, at the same time conserving these same nutrients from being leached out with the first percolating water.

Catonic exchange may be schematically represented by the equation:

$$AX + B^+ \rightleftarrows BX + A^+$$

where X represents the negatively charged clay particle, and A and B are cations. Exchange reactions are rapid and reversible. They of course follow laws of chemical equilibrium, but the complexity of the systems has so far precluded establishment of firm laws. With monovalent metal cations, exchange appears to follow the law of mass action directly. Introduction of multivalent cations confuses the situation. Further, the hydrogen ion is an anomoly in almost all soil chemical reactions.

A given soil has a more or less well defined cation-exchange capacity, depending on the types and amounts of clay minerals it contains. Agricultural soils possess exchange capacities in the range of about 5 to 40 milliequivalents per 100 grams of soil.

The implications of these soil characteristics should be apparent. The fission products produced by a nuclear explosion probably have a wide range of solubilities. As they become solubilized in the soil, they will become a part of the ionic exchange complex and be retained until absorbed by growing plants.

There is no reason to assume that a given fission product or other radioactive material will behave similarly in all soils. Soils of different types and in different locations are characterized by widely varying clay mineral contents, as well as varying composition of their ionic exchange constituents. Acid soils have predominantly hydrogen in their exchange complex, alkali soils sodium, and neutral soils calcium or magnesium. Again, there are numerous variations. Each combination of ionic constituents exerts its own characteristic influence on soil properties. Based on experience with addition of other ions to various types of soils it would be expected that fission product ions would behave differently in different soils, especially as regards uptake by plants. Thus, the consideration of the soil as a variable.

DECONTAMINATION

It is perhaps pertinent at this point to raise the question of decontamination. It should be realized that in so far as radioactivity is concerned, the term decontamination is a misnomer. There is no way of destroying or neutralizing radioactivity; it can only be transferred from one place to another. This is a very serious problem, because if the activity is widespread there is no safe place to transfer it.

We will consider here only the "decontamination" of soils to render them safe for cultivation and crop production. There are about three general methods for bringing this about.

The first of these is to scrape off the surface of the soil, thus physically removing the hazardous material. Only a moment's reflection is necessary to realize that this method is not practical, except perhaps for small localized spots. There would be no place to get rid of large amounts of such material.

The second method consists of leaching the radioactive material down out of the plant-root zone. This is also extremely difficult, apart from the risk of contaminating an improved water system. Pure water would do little good. It would have to contain ions to replace the radioactive ions on the soil exchange complex, and perhaps ions to solubilize some of the material. This would require large amounts of water in our water-poor state. Further, care would have to be taken that the treatment did not remove the soil's nutrient ions, thus rendering such soil infertile.

A third method is the use of growing plants to concentrate the radioactive material from the soil. This might be the most practical means, but also might require that the plant material be discarded for from one to several years. Time is the limiting factor for this scheme.

It is interesting to note that these same techniques are the ones used to reclaim alkali soils.

THE PLANT

One of natures most interesting and significant phenomena is the ability of growing plants to absorb carbon dioxide from the atmosphere, which contains only a small fraction of a per cent of this gas, and to elaborate it into tissue containing some 40 to 45 per cent carbon. Another phenomenon, not so widely recognized, is the ability of these same plants to concentrate mineral elements from the soil. The mechanism of plant uptake of mineral constituents is not well understood. Such constituents are normally absorbed against considerable concentration gradients. This requires energy, generally conceded to be provided by the respiration process.

The first step in plant uptake of mineral ions is apparently an ionic exchange of hydrogen or hydroxyl on the root surface with nutrient ions in the soil solution or on the soil's exchange complex. Metabolic action by the plant is necessary to get the ion from the root surface into the plant against a concentration gradient.

There is no present theory which explains satisfactorily the phenomenon of selective absorption of ions by plants. As an example of this, many plants contain more potassium than calcium, yet the soils in which they were grown contain a significant predominance of calcium over potassium, both in the soil solution and on the exchange complex. Even more dramatic is the ability of certain sea plants to accumulate large quantities of potassium and virtually no sodium. Yet the water in which they grow contains many times more

sodium than potassium and the two ions are chemically very similar.

There is very little knowledge available on the uptake of fission products by plants. Jacobson and Overstreet[2] found, for several fission products, that about 0.1 microcurie per gram of soil was sufficient to cause pronounced injury to plants. What about levels of activity not sufficient to injure plants? Can such plants transmit absorbed radioactive materials to animals with damage to the latter? We need a great deal of information of this type.

[2] *Soil Science*, **65**, 129–34 (1948).

It is known that different species of plants vary widely in their habits of selective absorption of mineral elements. Hence the consideration of the plant as a variable.

There are, of course, other variables, and all are interrelated. The ones discussed, however, indicate the nature of the over-all problem—and its complexity. There are many important questions to be answered, and many data required to provide the answers. We hope that calling attention to the nature and magnitude of the problems of this complex field will provide a stimulus to the seeking of answers to them.

Report of the

NEW ENGLAND ASSOCIATION OF CHEMISTRY TEACHERS

OFFICIAL BUSINESS

271st MEETING

The 271st meeting of the Association was held May 9, 1953, at Regis College in Weston, Massachusetts.

The Japanese cherry trees on the campus were in full bloom and the college authorities arranged for us the first Saturday without rain in many weeks, in order that we might enjoy them to the fullest.

Sr. M. Alice, S.S.J., officially opened the day's program with warm words of welcome. Professor Truman S. Licht of Boston College talked on the use of edge-punched cards for scientific literature filing. Professor Licht pointed out the need for a system better than those commonly used, and explained how a punched-card system, manually operated, can cut the work by one-fifth. Setting up a profitable and practicable system requires a certain amount of application, but once set up, it is easy to continue, and search for a certain reference is made vastly simpler. The talk was illustrated by slides. A bibliography on punched cards was distributed to those attending the meeting.

Dr. Lawrence J. Heidt, of the Department of Chemistry at Massachusetts Institute of Technology, gave, in the second paper, an account of his research on trapping sunlight energy by means of inorganic ions. The reaction of cerous, Ce^{3+}; and ceric, Ce^{4+}, ions with water under the influence of ultraviolet light produces hydrogen and oxygen gas, which may later be combined to produce heat and energy. At present the problem has not passed beyond the basic research stage, and Dr. Heidt forestalled obvious questions by stating in conclusion that, while it is not known whether this system can produce large amounts of energy for practical large-scale applications, still there is no evidence at present that it cannot.

After an excellent luncheon in the college dining room, the afternoon session was addressed by Drs. Neil Ault and Herbert Ueltz, from the Ceramics Division, Research and Development of Norton Company, Worcester, Massachusetts. The speakers discussed the constitution and composition of glasses, and illustrated their talk with samples and demonstrations, ranging from simple elemental glasses to the complex multicomponent ones.

BUSINESS MEETING

President Dorothy W. Gifford conducted the business meeting.

Two new members were welcomed into the Association by the Secretary:

Timothy E. McCarthy, Assistant Professor, Boston College, Chestnut Hill, Massachusetts.
Harry H. Williams, Assistant Principal, Horace Mann School New York, New York.

A Treasurer's report was read, which is given in full below under Annual Meeting.

Guy Burrill reported on the progress of the 15th Summer Conference the program for which had been sent to the printer.

Laurence S. Foster reported that the Northeastern Section of the A. C. S. had explored the possibility of summer employment for teachers in the Boston area and invited anyone interested to seek information from him.

ANNUAL MEETING

The Annual Meeting was opened immediately after the close of the 271st meeting by President Dorothy W. Gifford. The following reports were accepted as read:

Secretary's Report: The 14th Summer Conference was held at the University of Vermont, Burlington, Vermont, with William F. Ehret and Marco Scheer as Co-Chairmen. Attendance 239.

Five meetings have been held during the year, with the following registered attendance:

267th	St. Paul's School, Oct. 18, 1952	45
268th	Boston College, Dec. 13, 1952	105
269th	Wheeler School, Feb. 14, 1953	53
270th	Teachers' College of Connecticut, April 11, 1953	41
271st	Regis College, May 9, 1953	65

Membership Committee Report:

Total suspended, Jan. 1, 1953	44
Suspended and never heard from	16
Suspended, but reinstated	18
Resigned	10
New members	69
High school	36
College	32
Book Company representative	1
Joining at 14th Summer Conference	23
Total membership, May 9, 1953	559

LEALLYN B. CLAPP, *Secretary*

Treasurer's Report:

Dues, etc.	$2223.50
1951–52 balance	1385.24
14th Summer Conference surplus	222.49
Total	$3831.23
Disbursements	2171.79
Balance (May 9, 1953)	$1659.44

C. B. GUSTAFSON, *Treasurer*

Report of the Treasurer of the Endowment Fund:

Balance, May 10, 1952	$2286.41
Income credited May 10, 1952–May 5, 1953	
Watertown Cooperative Bank	25.00
Newton Savings Bank	32.79
Two per cent of dues, 1951–52	37.20
	$2381.40
Investments, May 5, 1953	
Five matured shares, Watertown Cooperative Bank, at cost	994.91
Balance in Newton Savings Bank, May 5, 1953	1386.49
	$2381.40
Income for the year May 7, 1952–May 5, 1953	$ 94.99

AVERY A. ASHDOWN, *Treasurer, Trustees Permanent Trust Fund*

The report of the Subcommittee on Science Fair Judging (Committee of Chemical Education) was read by Maurice Whitter in the absence of the chairman, Standish Deake, and accepted. The complete report was published in the June issue of the *News Letter*.

The Honorary Membership Committee nominated the following for honorary membership:

Ralph E. Keirstead, Bulkeley High School, Hartford, Connecticut.
John R. Suydam, Boston, Massachusetts.
Elbert C. Weaver, Phillips Academy, Andover, Massachusetts.

S. WALTER HOYT
CARROLL B. GUSTAFSON
LAURENCE S. FOSTER, *Chairman*

They were unanimously elected. The presentation of certificates will be made at a suitable ceremony during the 15th Summer Conference.

Helen W. Crawley, Walnut Hill School, Natick, Massachusetts, was elected to a three-year term on the Nominating Committee, to serve with Amasa F. Williston, B. M. C. Durfee High School, Fall River, Massachusetts, and Carl P. Swinnerton, Pomfret School, Pomfret, Connecticut.

The Nominating Committee presented the following slate of officers, who were duly elected:

President, Dorothy W. Gifford, Lincoln School, Providence, Rhode Island.
Vice-President, John A. Timm, Simmons College, Boston, Massachusetts.
Secretary, Leallyn B. Clapp, Brown University, Providence, Rhode Island.
Treasurer, Carroll B. Gustafson, Massachusetts College of Pharmacy, Boston, Massachusetts.
Northern Division Chairman, Austin B. Kibbee, Jr., Jay High School, Jay, Maine.
Central Division Chairman, Rev. Joseph A. Martus, S.J., College of the Holy Cross, Worcester, Massachusetts.
Western Division Chairman, Walter G. Stewart, Springfield College, Springfield, Massachusetts.
Southern Division Chairman, Edna M. Robbins, Mary C. Wheeler School, Providence, Rhode Island.
Curator, Ralph E. Keirstead, Bulkeley High School, Hartford, Connecticut.
Auditor, S. Walter Hoyt, 20 Stone Road, Belmont, Massachusetts.
Trustee of Endowment Fund, Mary B. Ford, 21 West Pine Street, Milford, Massachusetts.

AMASA F. WILLISTON
CARL P. SWINNERTON
RAYMOND S. TOBEY, *Chairman*

The President announced the following appointments:

Editor of the Report, Laurence S. Foster, Watertown Arsenal Laboratory, Watertown, Massachusetts.
Assistant Editor of the Report, William G. Chace, Lowell Technological Institute, Lowell, Massachusetts.
Assistant Editor of the News Letter, Eva M. Ruggli, 67 Dana Street, Cambridge, Massachusetts.
Publicity Agent, Eldin V. Lynn, Massachusetts College of Pharmacy, Boston, Massachusetts.

The Annual Meeting was adjourned *sine die* to reconvene at the 15th Summer Conference at 1:00 P.M., Friday, August 28, 1953.

LEALLYN B. CLAPP, *Secretary*

NECROLOGY

CHARLES H. STONE. The Necrology Committee has learned of the death in Florida some time ago of former president and honorary member, Charles H. Stone. Mrs. Stone has also passed away. Many of the older members will remember Mr. Stone, or Charlie, as he was known to his more intimate friends, as a frequent speaker at our meetings, particularly as an experimenter and demonstrator. His lecture-table experiments were a feature at many of our meetings and were inspiring and particularly helpful to our secondary-school teachers.

Mr. Stone, after graduating from Tufts College, taught first at Quincy, Massachusetts, High School and for many years at the Boston English High School where he was in charge of the College Preparatory Classes. He succeeded another NEACT president, Mr. Rufus P. Williams.

One summer he was in charge of a teachers training course in science at the Massachusetts Institute of Technology. He was a frequent contributor to the JOURNAL OF CHEMICAL EDUCATION and other publications on projects in the field of secondary-school chemistry teaching.

He served the cause of chemical education as a reader for the College Entrance Examination Board and as a member of the Board's Commission on the revision of the chemistry requirement.

After promotion to the post of Head of the Science Department of the Roxbury Memorial High School, his health suddenly made his retirement necessary and for several years before his decease he spent the winters at Orlando, Florida. For many years he was a trustee of his alma mater, the Vermont Junior College at Montpelier.

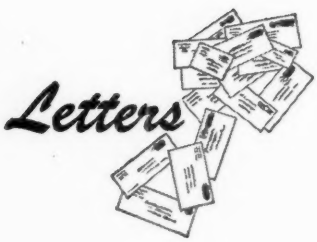
Data with reference to Mr. Stone's work in the NEACT:

Elected to membership, Nov. 9, 1907
Industrial Exhibits Committee, 1912
New Apparatus Committee, 1913, Chr. 1914
New Books Committee, 1915, 1916, Chr. 1924
Committee on Chemistry Library, 1917
Committee on Current Events and Publications, 1919, 1920
President, 1921, 1922
Chairman of Committee for the 100th Meeting
Elected to honorary membership, May 11, 1935

The following is quoted from the Report of the 165th Annual Meeting at Concord, New Hampshire, High School, where Mr. Stone was elected to honorary membership in 1935:

> "He is pronounced in his opinions, firm in his convictions, and a teacher among teachers . . . . Outside his chosen field he was a poet of no mean ability."

S. WALTER HOYT
for the Necrology Committee



To the Editor:

The teaching of systematic inorganic chemistry in our schools and universities has long suffered from the circumstance that there is no standard form of the periodic classification of the elements. For purposes of descriptive inorganic chemistry it is common practice to employ the Mendeleev type of periodic table in which the groups are divided into A and B subgroups, but a perusal of modern textbooks reveals several inconsistencies and in some cases considerable confusion in the grouping of the elements on this basis. In England, for example, we find that Sidgwick ["The Chemical Elements and Their Compounds," Oxford University Press **1950,** p. xxviii] presents a periodic table in which nitrogen and phosphorus, oxygen and sulfur, and fluorine and chlorine are represented as A elements, although it is categorically stated in the text that "from Group IV onwards the first two elements of every group belong definitely more to the B than to the A subgroups, whereas in Groups I, II and III they are more closely allied to the A elements." Apart from the representation of carbon and silicon as intermediate in character between A and B elements, this feature is correctly expressed in the classification adopted by Emeleus and Anderson ["Modern Aspects of Inorganic Chemistry," Routledge and Kegan Paul, London, **1952,** p. 2].

The periodic table published by Paneth [*Discovery,* **9,** 289 (1948)] differs in several respects from that used by other authors, and all the elements of the short periods are treated as B elements with the exception of lithium, sodium, beryllium, and magnesium. It is true that these inconsistencies may be avoided by treating the members of the short periods as Typical Elements, but the difficulty remains with the elements of the long periods.

The confusion arising from the different designation of subgroups is also evident in American publications. For example, Pauling ["General Chemistry," Freeman and Co., San Francisco, **1947,** p.61] represents the members of the transition series as A elements in accordance with the English custom, but in a recently published chart [*The Laboratory,* **1951,** 100] they are designated B elements, and it is claimed in this connection that the data are "based on the results of a comprehensive survey of chemistry professors and instructors from many colleges and universities."

The position at present is far from satisfactory and can only lead to further bewilderment of the student.

It may well be that the real remedy lies in (*a*) replacing the A and B subgrouping by the more rational classification into Normal Elements (N), Transition Elements (T) and Rare Earth Type (R) in accordance with their electronic structures, and (*b*) introducing a special group for copper, silver, and gold, since these metals can function chemically as normal or transition elements [WHEELER, *Chemistry & Industry*, **42**, 639 (1947); BOWDEN, "Physicochemical Periodic Table," Priory Press, Cardiff, **1947**; DURANT, "General and Inorganic Chemistry," Longmans, Green and Co., London, **1952**, p. 117].

It is surely time for the chemist to put his house or, at least, his table in order, and steps should be taken, preferably by an International Committee, to standardize for pedagogical purposes what is, after all, "the most basic document of chemistry."

S. T. BOWDEN

UNIVERSITY COLLEGE
CARDIFF, WALES

• ADVANCES IN CARBOHYDRATE CHEMISTRY VOLUME VII

Edited by *Claude S. Hudson*, National Institutes of Health, *Melville L. Wolfrom*, Ohio State University, and *Sidney M. Cantor*, American Sugar Refining Company. Associate Editors for the British Isles, *Stanley Peat*, University College of North Wales, and *Maurice Stacey*, The University of Birmingham. Academic Press, Inc., New York, 1952. ix + 370 pp. 15.5 × 23.5 cm. $7.50.

THE remarkable new tools and techniques at the disposal of today's carbohydrate chemists create not only a rapidly expanding wealth of information concerning the carbohydrates but also a need for easily accessible properties of reference compounds. This seventh volume of the "Advances in Carbohydrate Chemistry" series provides reviews of some of these new developments and also tables of reference compounds which will make easier the discovery of more information.

The following list of titles and authors will indicate the material covered and the international nature of the effort that is giving us this series. "The methyl ethers of the aldopentoses and of rhamnose and fucose," R. A. Laidlaw and (the late) E. G. V. Percival, The University of Edinburgh, Scotland. "1,6-Anhydrohexofuranoses, a new class of hexosans," R. J. Dimler, Northern Regional Research Laboratory, Peoria, Illinois. "Fructose and its derivatives," C. P. Barry and John Honeyman, King College, University of London. "Psicose, sorbose and tagatose," J. V. Karabinos, Saint Procopius College, Lisle, Illinois. "Acetals and ketals of the tetritols, pentitols and hexitols," S. A. Barker and E. J. Bourne, The University of Birmingham, England. "The gycals," Burckhardt Helferich, Chemisches Institute der Universität, Bonn, Germany. "The chemistry of the 2-amino sugars (2-amino-2-deoxy-sugars)," A. B. Foster and M. Stacey, Department of Chemistry, The University of Birmingham, England. "The size and shape of some polysaccharide molecules," C. T. Greenwood, The University of Edinburgh, Scotland.

There is little in this volume to interest the reader of popular discussions of science. The student of carbohydrate chemistry, however, will find described not only the reactions of easily recognizable types of compounds but also good discussions of less familiar compounds such as the carbohydrate-derived 1,6-anhydrohexofuranoses and glycals and the rare ketchexoses *d*-psicose, *d*-sorbose and *d*-tagatose. The final chapter listed above gives a clear yet concise description of the various methods available for determining size and shape of carbohydrate molecules and then presents an excellent review of our present knowledge concerning the molecular dimensions and structure of some polysaccharides other than starch and cellulose.

IRWIN B. DOUGLASS

UNIVERSITY OF MAINE
ORONO, MAINE

• ELECTRON STRUCTURES OF ORGANIC MOLECULES

***Lloyd N. Ferguson*, Associate Professor of Chemistry, Howard University. Prentice-Hall, Inc., New York, 1952. xi + 335 pp. Illustrated. 16 × 23 cm. $6.50.**

TO A beginning student in physical organic chemistry, Ferguson has made a thorough and digestible summation of current thinking on the electronic structures of organic molecules. Almost no reactions are discussed as such since the author adheres closely to the subject matter described by the title. The chapter on types of bonds, absorption spectroscopy, and aromatic substitution are very well written. Personally, I would like to have seen the chapter on intermolecular forces expanded. The author discusses free and hindered rotation but omits the timely topic of conformation or constellation. In the same chapter, he discusses H. C. Brown's *B* and *F* strain theories but omits *I* strain. This is perhaps a matter of taste, however.

The influence of Branch and Calvin, to whom the book is dedicated, is apparent on the author's thinking, although the book is not a second edition of their 1941 treatise. As an example, the chapter on magnetic susceptibility is largely concerned with metal chelates, a subject which might not have been included by many authors.

The book will make a good reference in physical organic chemistry though it is not apparent that it could be used alone as a text for a conventional course.

An author index for references to the original literature is included along with a subject index.

My adverse criticism is only minor and perhaps picayune. The author uses the language of the theory of resonance after introducing both it and molecular orbital theory in the early chapter on types of bonds. However, he is not always careful to say that the contribution of canonical structures to total structure depends on relative energies. For example, on page 276 he says, "The color of azulene is deepest because there is a larger *number* [italics mine] of polar forms to stabilize the excited state."

LEALLYN B. CLAPP

BROWN UNIVERSITY
PROVIDENCE, RHODE ISLAND

● MIXTURES

E. A. Guggenheim, **Professor of Chemistry at Reading University. Oxford University Press, New York, 1952. x + 270 pp. Illustrated. 16 × 24.5 cm. $8.50.**

IN THIS volume, Professor Guggenheim has attempted to "give an account of the application of statistical thermodynamics to certain models of solid, liquid, and gaseous mixtures." In so doing, he has brought together under one cover all of his important contributions to this field during the past 20 years; the result is a book which should be immensely valuable to anyone working on any aspect of nonelectrolyte solutions.

The model chosen for all cases discussed (except in the chapter on gaseous mixtures) is the *quasi-crystalline* one, for which the problem of calculating the thermodynamic functions (ΔF, ΔE, ΔS, etc.) for solutions reduces to the evaluation of the configurational partition functions for molecules supposed to be fixed on lattice sites; in addition, usually all but nearest-neighbor interactions are ignored. While such a model is an obvious one for solids, and solid solutions, its applicability to liquids and liquid solutions is by no means universally accepted.

While Professor Guggenheim attempts no detailed defense of this approach, other than to remark that a liquid is much more like a solid than a gas, two strong arguments can be made for it: (*a*) Whatever defects the quasi-crystalline model may have are presumably present in nearly equal degree before and after mixing, and may therefore be expected to have but small effect upon the different functions referring the solution to the standard state of the pure liquid components, and (*b*) the relative simplicity of the mathematical analysis of a rigid lattice permits a detailed treatment of this model to an extent far beyond that achieved with any other. In this reviewer's opinion, the quasi-crystalline approach to the statistical thermodynamics of solutions has been far more fruitful than any other; he knows of no other models from which useful equations can be obtained which are so nearly free of assumptions and approximations of uncertain validity.

Within the limitations of this assumed structure various aspects of solutions are explored in great detail. The "strictly regular solution" (a quasi-crystalline mixture of spherical molecules of almost equal size, not quite the same as Hildebrand's "regular solution") is analyzed very carefully and the various mathematical methods of attack (the "quasi-chemical" equilibrium equation, the Bethe method of local configurations, and Kirkwood's exact power-series development) are compared. The exact analogy between the strictly regular solution and order-disorder phenomena in solid solutions is shown very clearly and spelled out more carefully than ever before. A short chapter on the surfaces of simple liquid mixtures presents the author's beautiful treatment of the surface tension of the quasi-crystalline solution. (One hopes that more work on this fascinating and too-often neglected facet of solution theory will permit a longer chapter in the second edition.)

Molecules of different sizes are considered only for the case of *r*-mers occupying sets of sites in the quasi-lattice. An attempt is made to assess the mathematical inexactness in the Miller-Huggins-Guggenheim solution of the difficult combinational problem; here, unfortunately, the book could not anticipate a very recent (and more powerful) attack on this problem by Rushbrooke, Scoins, and Wakefield. The resulting equations are especially important for solutions of macromolecules; the final chapter is a brief but excellent review of this vast topic.

It is regrettable that two very interesting problems of current interest, volume changes on mixing and anomalous behavior of substances in the critical region, are not amenable to treatment by this model, and were therefore not discussed. An exception to the strict adherence to this model is the chapter on gaseous mixtures, an excellent discussion of the second virial coefficient of mixed gases, based upon simple models of intermolecular forces.

Wherever possible, the theoretical equations are compared with experimental data. Unfortunately this is all too infrequent, although the fault is not the author's. While there is a wealth of experimental data on nonelectrolyte solutions, there is a paucity of first-class data on systems which might be expected to conform moderately well to the simple model assumed (*e. g.*, approximately spherical models of approximately the same size).

Even were the quasi-crystalline model far less relevant to liquid solutions than it appears to be, this work would be valuable solely as an excellent exercise in the application of statistical mechanics to thermodynamic problems. The elegant, but simple, grand partition function is used throughout. Because of the simplicity of the model, precise but simple mathematical methods can be employed throughout, and where further approximations are necessary, they can be clearly defined, and an attempt made to estimate the error so introduced. The casual reader may at times become impatient with the detailed exploration of effects which turn out to be small or even negligible, and with the inclusion of tables comparing several different equations which lead to results which are indistinguishable at the present level of experimental precision. He should not, however, underestimate the value of a negative result; it is very comforting to know that certain effects are negligible.

In reviewing another book in this field, Professor Guggenheim remarked (with complete justice) that the number of trivial misprints in the text was about ten times what could be regarded as excusable. Professor Guggenheim and the Oxford University Press are to be congratulated on maintaining with this book their usual high standards; this reviewer could find so few misprints (all trivial) that he is tempted to say that this book contains a number which is an "order of magnitude" less than normal.

ROBERT L. SCOTT

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LOS ANGELES, CALIFORNIA

● AN INTERMEDIATE LABORATORY COURSE IN CHEMISTRY

M. L. McGlashan **and** ***C. J. Wilkins,*** **Lecturers in Chemistry at Canterbury University College, Christchurch, New Zealand. North-Holland Publishing Co., Amsterdam, 1953. vi + 139 pp. Illustrated. 14 figs. 14 × 21.5 cm. 13/6 d.**

IN THIS brief laboratory manual the aim of the author is: "to place the emphasis on chemical principles and chemical reactions rather than on qualitative and volumetric analysis. Nevertheless the student following this course is introduced to the usual range of analytical methods." The course is designed for students who have "some previous acquaintance with chemistry."

The individual experiments, usually introduced by a brief discussion, are arranged under nine chapter headings, *viz.*, 1. Quantitative Aspects of Chemical Combination, 2. Preparation and Analysis of some Inorganic Compounds, 3. Chemical Equilibrium—The Law of Mass Action, 4. Oxidation and Reduction, 5. Hydrogen Ion Equilibrium—Acids and Bases, 6. Equilibria in Saturated Salt Solutions—The Solubility Product, 7. Complex Ions, 8. The Chemistry of Anions, 9. The Chemistry of Cations.

In addition to the 97 experiments included in the foregoing chapters, there are four pages of notes on the Analytical Groups. The Appendix (I, II, III) contains tables for identification of anions, cations, vapor pressures, atomic weights, and logarithms.

The directions and the diagrams of apparatus are unusually explicit and instructive. The term "oxidation level" appears on pages 102 and 103, and "oxidation state" on page 108.

For the busy laboratory instructor and stockroom attendant, a list of supplies necessary for each experiment would be helpful. The time necessary for completing the various experiments would seem to vary considerably, thus entailing a careful planning of the schedule.

For a special type of laboratory course in which one might place greater emphasis upon the quantitative work of general chemistry with some emphasis upon analytical chemistry, this manual can be well recommended.

ARNOLD J. CURRIER

PENNSYLVANIA STATE COLLEGE
STATE COLLEGE, PENNSYLVANIA

● THERMAL DIFFUSION IN GASES

***K. E. Grew,* University College, Exeter, and *T. L. Ibbs,* University of Birmingham. Cambridge University Press, New York, 1952. xi + 143 pp. 40 figs. 17 tables. 14.5 × 22.5 cm. $4.50.**

THIS book is a monograph of thermal diffusion in gases with ten pages devoted to thermal diffusion in liquids. An informative outline of the theory of thermal diffusion is given, together with an eight-page chapter on experimental methods. Most of the monograph deals with the experimental and theoretical results and their comparison. A 16-page chapter deals with the Clausius-Dickel separating column for gases. Here the elementary theory is given, together with experimental results. The book is a good survey of the better established parts of the field. The more advanced aspects of the subject must be read elsewhere. The efforts at theories of thermal diffusion of liquids are passed over lightly. The book is expensive but will be useful to those wishing to survey the present status of this important field.

HENRY EYRING

UNIVERSITY OF UTAH
SALT LAKE CITY, UTAH

● TECHNICAL REPORTING

***Joseph N. Ulman, Jr.,* Massachusetts Institute of Technology. Henry Holt and Co., New York, 1952. xiv + 289 pp. Illustrated. 17 × 24 cm. List price, $4.75; school price, $3.50.**

THIS excellent book is planned for anyone—undergraduate, graduate, or in industry—whenever he needs it. The author's considered opinion is that most students of engineering and science are not receptive to instruction on the writing of reports until some inner urge or external pressure actually compels them to write one. He feels, too, that if technical writing is to be taught successfully in school, it will be learned best through correlating the topics assigned in an English class with the student's major field of technical interest.

Obviously based on sound experience, both in teaching and in industry, this book deals with all the fundamentals needed for good reporting. Part I covers background information, the selection and organization of data, correct emphasis and logical development, visual aids, and the proper appearance of the paper as a whole. Part II, specifically on reports, deals with the form and function of many formal and informal types, and includes applications for a job, laboratory notebooks, and papers for professional groups. The fine points of difference in the requirements for the oral presentation and for publication could well be taken to heart by everyone that must stand up and speak a piece on anything in science and technology, to his professional brethren, a local Kiwanis luncheon, or a Women's Club.

In Part III, on Tools and Methods, Professor Ulman shows that he is a good teacher, skilled in the art of subtle persuasion. Against all the recognized odds, especially the psychological block against any study of English *per se*, and the acute allergy to grammar in most students (and practitioners) in technical fields, he proceeds warily to declutter the few basic rules he considers essential for good expression. His objectives in style, sentences, punctuation, and other points are emphasized by many well-chosen examples and suggested corrections, about which, however, he is not at all stuffy or dogmatic. All this is presented in such seemingly casual good humor that self-improvement becomes a challenge and a game. Any reader—you, for instance—before you know it, will actually have learned what this author intended to teach you, and you will like it.

Everything usually covered by the mechanics of good writing has been included: abbreviations, capitalization, quotations and citations, headings and subheadings, illustrations, tables, slides, and processes for reproducing reports and other papers. The system used for cross references is simple and satisfying; if the reference is to 12.2.8, for example, you just flip the pages to Chapter 12 and find the information in the eighth subtopic of the second main division.

The concluding chapter skillfully summarizes the entire book in numbered rules. A rather long appendix reproduces letters and typical reports, well annotated with explanatory comments. The bibliography lists several helpful books for further study; and there is a good index.

The book is beautifully made, in fine typography and artistic layout on good paper. If an experienced writer might question some of the colloquialisms and journalese here and there, and possibly prefer other corrections for bad examples, these reactions would only prove that everyone, from the most blasé to the most desperate, can find "Technical Reporting" stimulating and helpful.

FLORENCE E. WALL

NEW YORK, NEW YORK

● BIOLOGICAL CHEMISTRY

***Alexander Gero,* Associate Professor of Pharmacology, Hahnemann Medical College, Philadelphia. The Blakiston Co., Inc., New York, 1952. xvi + 340 pp. 22 figs. 16 × 23.5 cm. $5.**

AN ORGANIC chemist writes an introductory book for biochemistry students. It is a real attempt to bridge the gap between the conventional one-year organic course and the typical biochemistry given in the medical colleges. Just where such a course can be given is not too clear, but there can be no doubt that professors of biochemistry would certainly welcome students who have mastered the principles as given by Dr. Gero.

With the exception of two chapters which very briefly describe a number of physical-chemical terms, and the third chapter which is an introduction to physical organic chemistry, the book is largely an organic chemistry book using molecules of biochemical interest as examples. The chapter headings are appropriate. *An Introduction to* proteins, carbohydrates, etc. means just that. As an example: the protein section deals with organic acids, amines, amides as such; a little about colloids is given; amino acids and zwitter ions are included; then are given classification and structure of proteins. Of 20 pages devoted to this topic, 15 are actually introductory, and of the remaining five pages one is devoted to the chemical composition of the enzymes and four to the structure of proteins.

The chemistry of steroids, isoprenoid compounds, aromatic and heterocyclic compounds is taken next. Biochemical Reactions is an attempt to show how these complicated processes, either biosynthesis or break-down, follow well-known name reactions or accepted reaction mechanisms. Much is covered in this chapter, the only true biochemistry section in the book. In the next chapter on Chemical Structure and Physiological Activity too many isolated facts are given before the theory.

The final chapter gives step-by-step process of the synthesis of some biological compounds. Each step is broken down to its basic reaction, *i. e.*, Friedel-Craft reaction, benzoin condensation, Mannich reaction, etc. These syntheses are more of academic interest.

For each chapter there is a suggested reading list given in Chapter 16, and at the end of most chapters there are some essay-type questions.

One inconsistency was noted. Indoles and pyrrols were first given as

and later as

This latter type is definitely misleading even if it does save space. One incompleteness noted was that the role of radioisotopes was neglected.

This book does what it set out to do. It is an "advanced organic chemistry with special accent on that material most pertinent to the subsequent study of physiological chemistry." It was not written for the conventional biochemical course but for that in between state, the course that should be a prerequisite for modern biochemistry. To get the true philosophy of this text, the preface must be read.

ARTHUR FURST

STANFORD UNIVERSITY SCHOOL OF MEDICINE
SAN FRANCISCO, CALIFORNIA

● INORGANIC CHROMATOGRAPHY

Orsino C. Smith, **Superintendent of Vinvale Refinery, Richfield Oil Corporation. D. Van Nostrand Co., Inc., New York, 1953. viii + 136 pp. 5 color plates. 6 figs. 15.5 × 23.5 cm. $5.**

THIS very readable book contains a comprehensive survey of chromatographic methods as applied to inorganic analysis. It has a sufficient number of diagrams, and is beautifully illustrated with colored plates of chromatograms obtained during mineral analysis. Also, it includes a bibliography of 168 references to the literature and both an author and a subject matter index. The book is divided into two parts: Part I, History and Theory; Part II, Application.

Some of the chapter headings of Part I and a few comments on the contents of other chapters will serve to indicate the scope of the theory discussed. There are chapters on: Column Chromatography, Paper Chromatography, Chromatography by Ion Exchange, and Radioactive Tracers in Chromatography. Also, there are short chapters devoted to the work of Tswett and the earliest workers in the field of inorganic chromatography. Kinds of adsorbents, the selectivity and sensitivity of adsorbents, the development of the chromatogram, and the theory of adsorption are considered. Under the theory of adsorption the author discusses factors influencing adsorption and the various theories regarding the nature of adsorption. Although these theories are treated very briefly in a short introductory chapter the material is organized to give the reader some clear ideas of the factors involved.

Chapter 8, the first chapter of Part II, contains a discussion of adsorbents used in column adsorption schemes of chromatographic analysis with some practical suggestions about the adsorbents which have proved most successful in the inorganic analysis for which laboratory instructions are given in Chapter 9. In his laboratory directions for the analysis for metal ions the author follows the group separation as used in his former book, "Identification and Qualitative Chemical Analysis of Minerals," D. Van Nostrand. The instructions for the chromatographic detection of the elements in the ten groups into which he divides them include such groups as the acid or tungsten group, the oxalic acid or rare earth group, and the zirconium group in addition to the more usual groups. Although some of the details of laboratory procedure are intentionally omitted from this limited book, one familiar with the usual schemes of mineral analysis should not find difficulty in following the instructions for the chromatographic analysis of the various groups considered.

The author states of the investigations reported in the book: "The primary object of this investigation was to obtain chromatographic bands or zones for the various elements of the groups with all of them present, a condition which seldom occurs. When this was accomplished with any group, work on it was dropped. Therefore, it is very probable that refinements are possible in most of them, and the applications here should be considered as only the first step in the application of chromatography to routine qualitative analysis."

The material in "Inorganic Chromatography" is well organized and is clearly presented. The arrangement of material in both the theoretical and the practical parts of the book is one which makes it easy for the reader to look up any particular point with which he may be concerned at the moment. Anyone interested in this new and increasingly important field will want to own this book or will want it easily available to him in a library.

H. H. FILLINGER

HOLLINS COLLEGE
HOLLINS COLLEGE, VIRGINIA

● CHEMIE LEXIKON

H. Römpp. **Third edition; Franckh'sche Verlagshandlung, Stuttgart, 1952–53. Volume I (A–K): 1032 pp.; Volume II (L–Z): 1072 pp. 18 × 25 cm. DM 168 (approx. $40).**

THE worth of a scientific reference book such as this monumental work can be well judged by the rate at which its successive editions are demanded. The first edition (1945–46) contained 10,000 entries; the present edition, about 15,000 entries, has taken account of the progress of chemistry and closely allied fields through a large part of 1952. It is the obvious intention to keep the material up to date. The entries are arranged alphabetically and the length ranges from one line to several pages. Most of the discussions are provided with references to the scientific or trade literature. Trade names, abbreviations, manufacturers, etc., are given where possible. Brief biographical sketches of eminent chemists, lists of publishers, and short accounts of periodicals, are typical unexpected and pleasant finds that greet the reader. The volumes were obviously not written for chemists alone; the workers in all scientific fields and the well rounded public will find much of value here.

The mass of useful information assembled here is truly astounding. The author (who invited the cooperation of a goodly number of specialists) is a skilled writer who has been particularly successful in popular presentations of scientific topics. This ability to write in clear but nevertheless accurate terms is reflected here.

The printing, paper, and binding are excellent. This truly encylopedic pair of volumes is an instance of typical German diligence, thoroughness, and devotion. To the German-reading chemist and his fellow scientists in other fields, the set offers *multum in parvo.*

RALPH E. OESPER

UNIVERSITY OF CINCINNATI
CINCINNATI, OHIO

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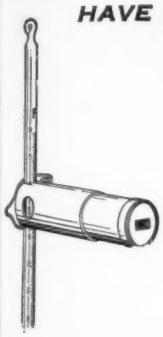

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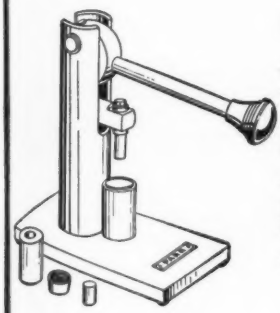

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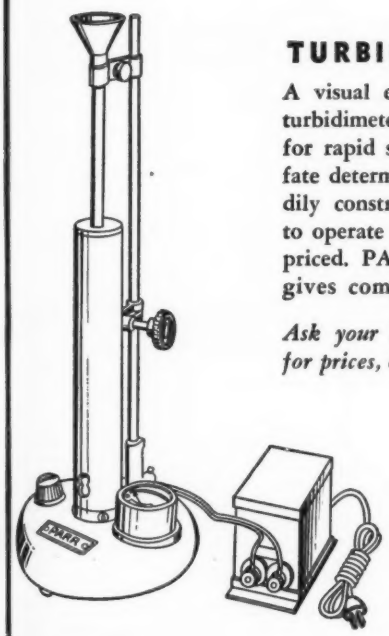

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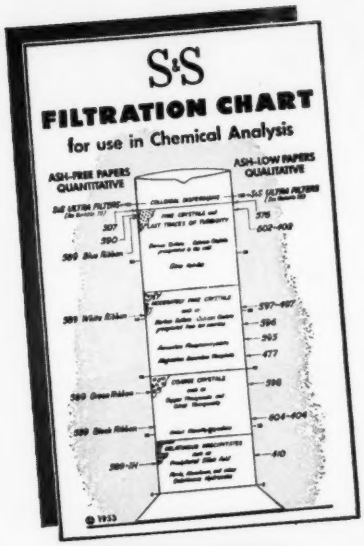

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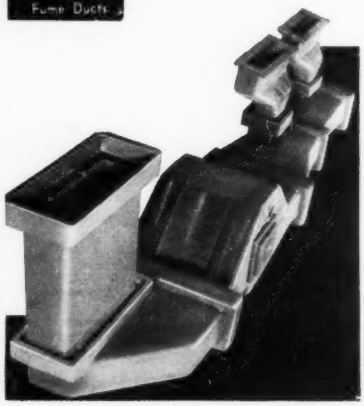

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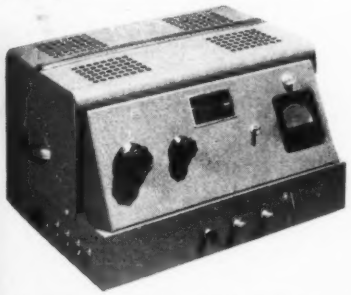
Out of the Editor's Basket

Precision Voltage Stabilizer

The users of spectrophotometers are offered a new highly regulated 6-volt d.-c. power unit, designed to completely eliminate storage batteries or storage battery power supplies. The Nylab Precision Voltage Stabilizer is recommended for general laboratory purposes, as well as for the Beckman Model DU or Model B Spectrophotometers to supply their 6- and 2-volt requirements.



Operated from the 115-volt a.-c. power line, either 50 or 60 cycles, the new Voltage Stabilizer has the following output characteristics: a highly regulated voltage from the main terminals, adjustable between 5.5 and 6.5 volts d. c., with currents up to 5 amperes; also, fully stabilized lower voltages from an intermediate terminal connecting with a built-in voltage divider, which can be set by the user to deliver any value from 0.0 to 6.5 volts d. c. at currents up to 1 ampere; an option of delivering up to 6 amperes from the main terminals (stabilized 5.5–6.5 volts) by disconnecting the voltage divider; a further option of deliverng any voltage from 0 to 10 volts from the main terminals by sacrificing part of the voltage regulation. In normal operation, the voltage regulation is within ±0.01% of the rated output, against a.-c. line voltage changes of ±15% the random fluctuations of output being less than ±0.0005 volt at the 6-volt terminal.

For further information write New York Laboratory Supply Co., 78 Varick St., New York 13, New York.

High-Resolution Nuclear Magnetic Resonance Spectrometer

Molecular structures are determined and components in a mixture identified by the new Varian Model V-4300 High-Resolution Nuclear Magnetic Resonance Spectrometer. Principally applicable to compounds containing hydrogen or fluorine, the new instrument can detect differences in the nmr (nuclear magnetic resonance) structural spectra of isomers. Comparison of resulting oscilloscope traces against those obtained from known fluorine compounds makes it possible to identify structure in the two isomers.

By the addition or substitution of various available radiofrequency units the Model V-4300 Spectrometer can be applied to studies of many other isotopes.

In operation, the high-resolution spectra are observed and either recorded on a strip chart or photographed from an oscilloscope screen. Related units utilized include a magnetic field system provided by standard Varian electromagnets, regulated magnet power supplies, and voltage regulator.

Additional details are available from Varian Associates, Dept. NEBP, San Carlos, California.

Portable Cooling Unit

One of the many laboratories now employing a portable cooling unit is the Kettering Foundation at Antioch College, Yellow Springs, Ohio.

They use a unit on wheels known as the Junior Chil-er made by Mayer Refrigeration Engineers, Rutherford, New Jersey. The unit has a recirculating capacity of 3 gallons per hour. It cools liquids to minus 10°F. under thermostatic control of plus or minus $\frac{1}{2}$ degree. When equipped with a heating element, temperatures may be controlled up to 140°F. An in-

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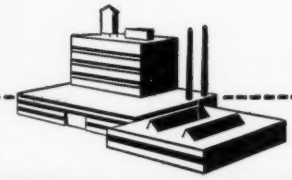

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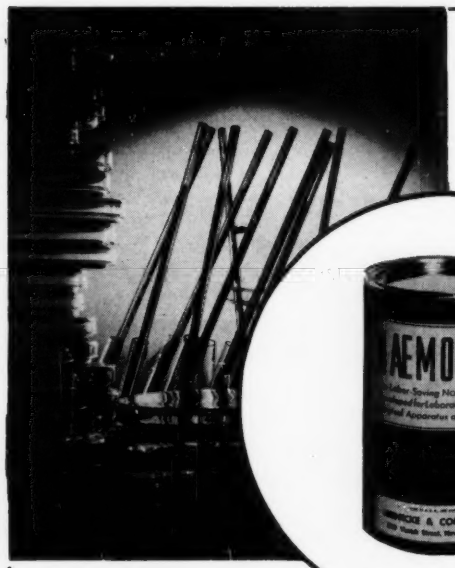

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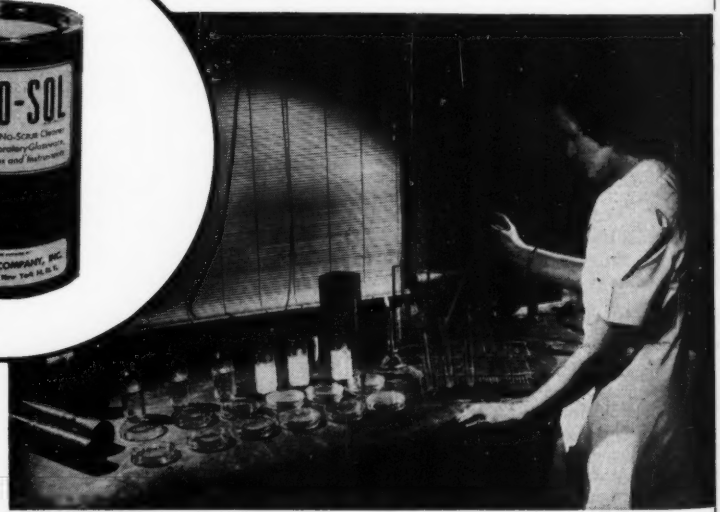

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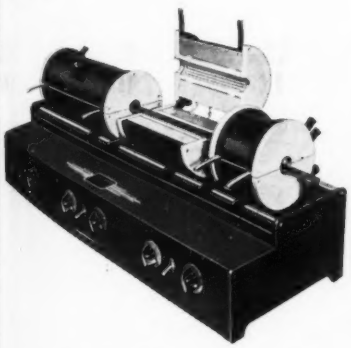
Hevi Duty Electric Co. announces a new model Organic Combustion Tube Furnace. Three separate furnaces mounted on rails enable the operator to use this furnace as one complete unit or as three separate units. Each of the units has individual temperature control. A new tape changing transformer with 36 steps of temperature control for each section is mounted in the base. This arrangement makes the furnace and controls one complete unit, thus doing away with separate rheostats and input control devices.



This organic Combustion Tube Furnace is used for carbon determinations and other laboratory research requiring temperatures up to 1900°F. Hevi Duty Electric Co., Milwaukee 1, Wisconsin, for Bulletin LAB-735-R.

New Literature

● Several interesting and informative articles are contained in the latest issue of *Cenco News Chats*. One, by Edward M. Nakaji, is devoted to "Testing High Vacuum Pumps." Another contains a wealth of information about the new Cenco-Riverbank Frequency Standards. A new Oil Diffusion Pump is described in another article and a trip through the laboratories of Universal Oil Products Co. is shown in pictures. For your free copy, write Editor, *News Chats*, Central Scientific Co., 1700 Irving Park Rd., Chicago 13, Illinois.

● The first supplement to the current published list (No. 38) of more than 3,500 organic chemicals supplied by the Eastman Kodak Co. has just been announced. The supplement lists 40 additions to the catalogue, showing the name of chemical, its melting or boiling point, structural formula, molecular weight, and price according to quantity. It also includes removals and price changes.

Copies of the supplement may be obtained without charge, by writing to Eastman Organic Chemicals Dept., Distillation Products Industries, Rochester 3, New York.

● A new edition of *"What's New for the Laboratory"*—18th in the series—has just been announced by the Scientific Glass Apparatus Co., Inc., Bloomfield, New Jersey.

Many new items are featured in this 16-page brochure. Included are: a new line of low-priced industrial balances, a number of polyethylene aids, a utility water bath, duplex heater, penetrometer, wet test meter, laboratory glassware washer—plus many others.

Write directly to the Scientific Glass Apparatus Co., Inc., Bloomfield, New Jersey for your free copy of *"What's New."*

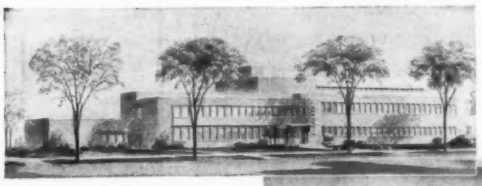
● Schaar and Company offers a new 16-page bulletin of apparatus and equipment, featuring a complete line of Heat Treating Equipment, and Dehumidification Equipment. Many other newly introduced instruments for research, development, and control laboratories are included. Copies are available upon request from Schaar and Co., 754 W. Lexington St., Chicago 7, Illinois.

● Latest information on the new Beckman Aquameter—a high-speed electronic device which titrates for moisture automatically—has been compiled in an illustrated 4-page folder for general release.

This instrument utilizes the Karl Fischer "dead-stop" reaction for water measurements, important because of its high inherent precision and applicability to more substances than any other routine method.

The brochure explains push-button moisture testing of such materials as paper, foodstuffs, petroleum products, alcohols, pharmaceuticals, ethers, animal tissue, antibiotics and blood. Also described is the Aquameter's simple operation, which permits untrained technicians to run precise water analyses in one or two minutes.

Descriptive literature can be obtained from Beckman Instruments, Inc., South Pasadena 1, Calif., through requests for Data File 307-36.



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References

(1) Ind. Eng. Chem. 25-653 (June, 1933)

(2) Ind. Eng. Chem. 25-1112 (Oct., 1933)

(3) National Bureau of Standards Journal of Research 12-241 (Feb. 1934, R.P. No. 649)

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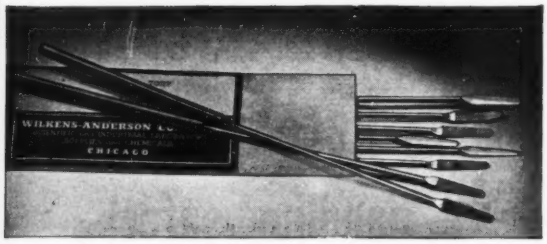

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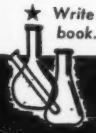

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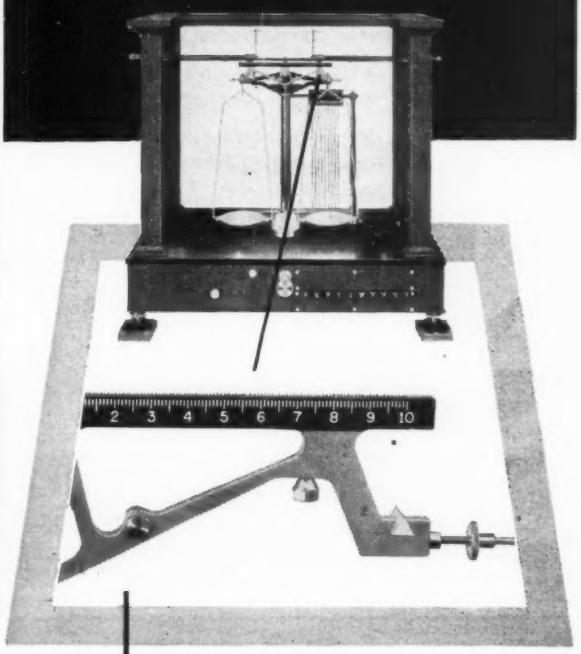

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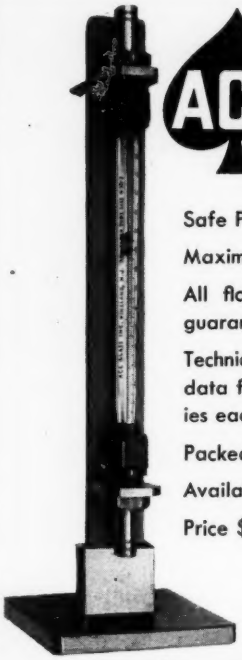

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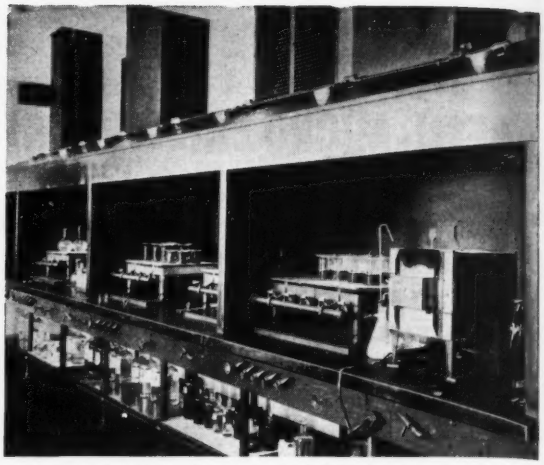

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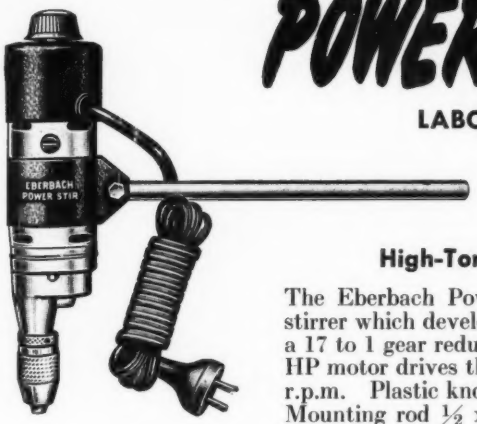

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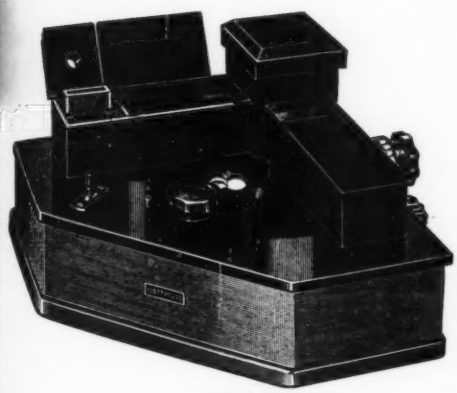

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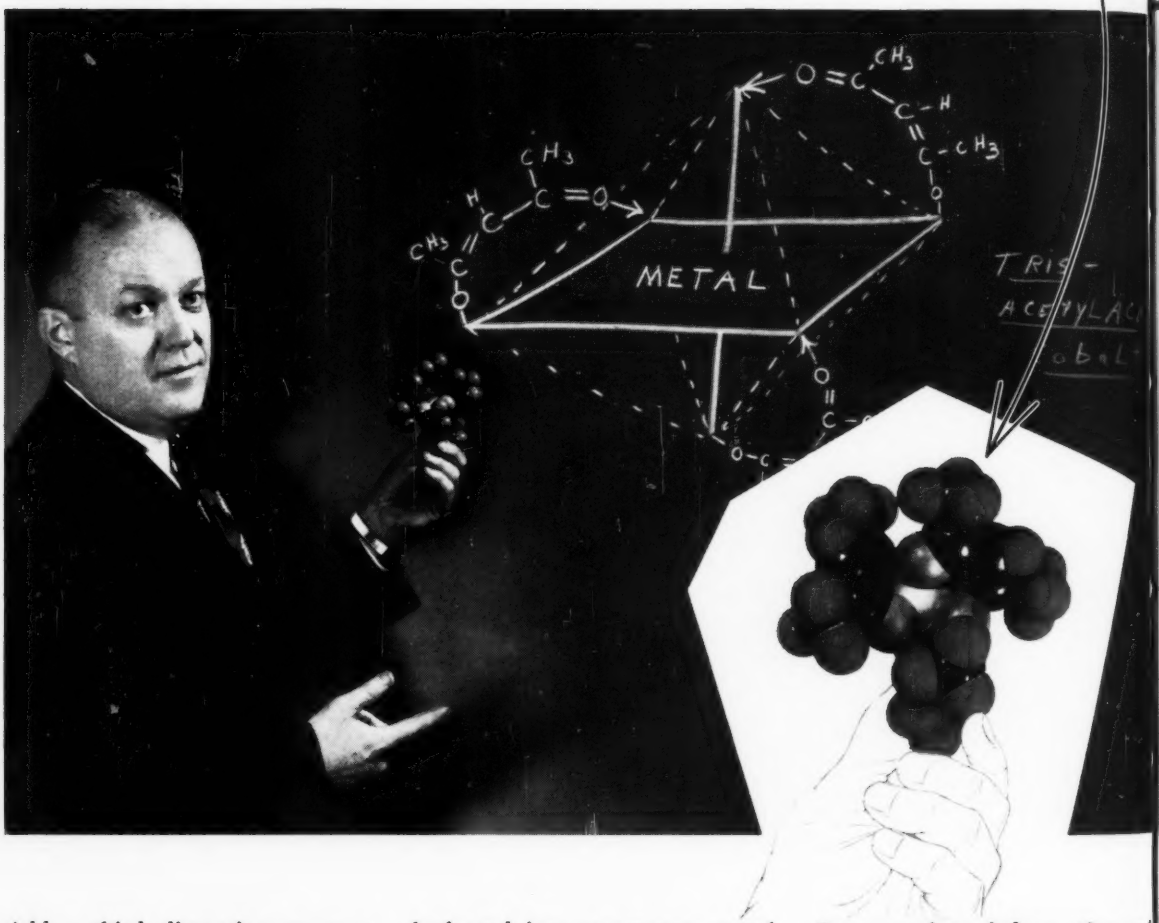

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